C156-E205-01EN

MCJ3230AP

OPTICAL DISK DRIVE

PRODUCT MANUAL

FUJITSU

FOR SAFE OPERATION

Handling of This Manual

This manual contains important information for using this product. Read thoroughly before using the product. Use this product only after thoroughly reading and understanding especially the section "Important Alert Items" in this manual. Keep this manual handy, and keep it carefully.

FUJITSU makes every effort to prevent users and bystanders from being injured or from suffering damage to their property. Use the product according to this manual.

This product is designed and manufactured for use in standard applications such as office work, personal devices and household appliances. This product is not intended for special uses (atomic controls, aeronautic or space systems, mass transport vehicle operating controls, medical devices for life support, or weapons firing controls) where particularly high reliability requirements exist, where the pertinent levels of safety are not guaranteed, or where a failure or operational error could threaten a life or cause a physical injury (hereafter referred to as "mission-critical" use). Customers considering the use of these products for mission-critical applications must have safety-assurance measures in place beforehand. Moreover, they are requested to consult our sales representative before embarking on such specialized use.

First Edition July 2001

C156-E205-01EN

Revision History

(1/1)

Edition	Date	Revised section (*1) (Added/Deleted/Altered)	Details
01	2001.07.24	—	—

*1 Section(s) with asterisk (*) refer to the previous edition when those were deleted.

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Preface

This manual describes the MCJ3230AP 90 mm (3.5-inch) optical disk drive.

This manual provides an overview of the above optical disk drives, and explains their specifications, the requirements and procedures for installing them in a system, and how to clean them.

The manual is intended for users who have a basic understanding of optical disk drives and their use in computer systems.

See "Manual Organization" for details of the organization of manuals related to optical disk drives and the scope of this manual. Use the other manuals shown in "Manual Organization" together with this manual when necessary.

The organization of this manual, related reference manual and conventions for alert messages follow.

Overview of Manual

This manual consists of the following six chapters, glossary, and abbreviation:

Chapter 1 General Description

This chapter introduces the MCJ3230AP optical disk drive and describes its features, drive configuration, and system configuration.

Chapter 2 Specifications

This chapter describes the specifications of the MCJ3230AP optical disk drive and the specifications of optical disk cartridges.

Chapter 3 Installation Requirements

This chapter describes the basic environmental, mounting, power supply, and connection requirements for installing the MCJ3230AP optical disk drive in a user system.

Chapter 4 Host Interface

This chapter describes the host interface of the MCJ3230AP optical disk drive.

Chapter 5 Diagnostics and Maintenance

This chapter describes how to operate and clean the MCJ3230AP optical disk drive. This chapter also describes how to operate and clean optical disk cartridges.

Chapter 6 Diagnostics and Maintenance

This chapter describes the self-diagnostics functions and maintenance of the MCJ3230AP optical disk drive.

Glossary

The glossary describes the technical terms that need to be understood to read this manual.

Acronyms and Abbreviations

This manual contains a list of the abbreviations used in this manual and their meanings.

CONVENTIONS USED IN THIS MANUAL

Throughout this manual, the MCJ3230AP optical disk drive are described as an "ODD," "drive," "unit," "target (TARG)," or "device."

Decimal values are indicated without any modifiers added.

Hexadecimal values are indicated as X'17B9', 17B9h, 17B9H, and 17B9H.

Binary values are indicated as "010" and 010b.

Conventions for Alert Messages

This manual uses the following conventions to show the alert messages. An alert message consists of an alert signal and alert statements. The alert signal consists of an alert symbol and a signal word or just a signal word.

The following are the alert signals and their meanings:

⚠DANGER	This indicates a hazardous situation *likely* to result in *serious personal injury* if the user does not perform the procedure correctly.
⚠WARNING	This indicates a hazardous situation *could* result in *serious personal injury* if the user does not perform the procedure correctly.
⚠CAUTION	This indicates a hazardous situation *could* result in *minor* or *moderate personal injury* if the user does not perform the procedure correctly. This alert signal also indicates that damages to the product or other property, *may* occur if the user does not perform the product correctly.
IMPORTANT	This indicates information that could help the user use the product more efficiently.

In the text, the alert signal is centered, followed below by the indented message. A wider line space precedes and follows the alert message to show where the alert message begins and ends. The following is an example:

(Example)

⚠CAUTION

Low temperature burns: The surface temperatures of some ICs on the printed circuit board unit in the optical disk drive exceed 55°C while operating. Be careful of low tenperature burns.

The main alert messages in the text are also listed in the “Important Alert Items.”

Attention

Please forward any comments you may have regarding this manual.

To make this manual easier for users to understand, opinions from readers are needed. Please write your opinions or requests on the Comment at the back of this manual and forward it to the address described in the sheet.

DISCLAIMER

Failure of the MCJ3230AP optical disk drive is defined as a failure requiring adjustment, repair, or replacement. Fujitsu is not responsible for failure due to misuse, operation outside the specified environment conditions, power line trouble, controller problems, cable failure, or other failure not caused by the optical disk drive itself.

Important Alert Items

Important Alert Messages

The important alert messages in this manual are as follows:

CAUTION

A hazardous situation *could* result in *minor* or *moderate personal injury* if the user does not perform the procedure correctly. Also, damage to the product or other property, *may* occur if the user does not perform the procedure correctly.

Task	Alert message	Page
Operation	**Low temperature burns:** The surface temperatures of some ICs on the printed circuit board unit in the optical disk drive exceed 55°C while operating. Be careful of low tenperature burns.	3-1
Installation	**Device damage:** 1) Shock or vibration applied to the drive that exceeds the values defined in the standard damage the drive. Use care when unpacking. 2) Do not leave the drive in dirty or contaminated environments. 3) Since static discharge may destroy the CMOS devices in the drive, pay attention to the following points after unpacking: • Use an antistatic mat and wrist strap when handling the drive. • Hold the mounting frame when handling the drive. Do not touch the PCA except when setting the switches. 4) When handling the drive, hold both sides of the mounting frame. When touching other than both sides of the mounting frame, avoid putting force. 5) Do not forcibly push up the end of the header pin of the printed circuit board unit when handling or setting the drive.	3-18

Task	Alert message	Page
Installation	**Device Damage:** Be sure to turn on the power supply before inserting your cartridge for the first time. It releases the device from transport protection and enables you to insert the cartridge. The device may be damaged if you insert the cartridge without releasing the protection. From the next time, you don't need to turn on the power supply beforehand. Before moving the drive, remove the optical disk cartridge. If the drive is moved with the optical disk cartridge loaded in it, the head may move back and forth in the drive to damage the head or disk and reading the data may fail.	3-19
	1) Make sure that the system power is off. 2) Do not connect or disconnect any cable when the power is on.	3-22
	Device Damage: Before demounting the optical disk drive, turn off the system power. Do not remove screws securing the cables and drive when the power is on.	3-23
Cleaning cartridge	**Device Damage:** Be sure to use the dedicated head cleaner described above.	5-6
	Damage for disk medium: Use the cleaning solution and cleaning cloth specified in Table 5.2. If other than the specified items is used, disk media surface may be damaged.	5-12
	Damage for date medium: Do not use this cleaning kit for the floppy disk or the optical disk cartridge used for other optical disk drive.	5-12
	Damage for disk medium: Clean the cartridge at clean place. Put a disposable groves at cleaning so that the fingerprint does not put on the disk media (recommendation).	5-12
	Damage for disk medium: At setting the cartridge to the setting case, do not apply the heavy shock and push hardly.	5-13
	Eye inflammation: In case of contact with eyes, immediately flush eyes with water.	5-14
Maintenance and Repair	**Data loss:** In case of regular repair, the optical disk cartridge should not be attached except where the cartridge causes the error. And before having the drive repaired, save the data in the cartridge. Fujitsu is not responsible for data last during maintenance or repair.	6-3

MANUAL ORGANIZATION

OPTICAL DISK DRIVES PRODUCT MANUAL (C156-E205)	1. GENERAL DESCRIPTION 2. SPECIFICATIONS 3. INSTALLATION REQUIREMENTS 4. HOST INTERFACE 5. OPERATION AND CLEANING 6. DIAGNOSTICS AND MAINTENANCE
OPTICAL DISK DRIVES MAINTENANCE MANUAL (C156-F043) <This manual>	1. MAINTENANCE AND DIAGNOSIS 2. FAULT ANALYSIS 3. REMOVAL AND REPLACEMENT PROCEDURES 4. PRINCIPLES OF OPERATION 5. CLEANING

REFERENCED STANDARDS

The product specifications and functions described in this manual conform to the following standards:

Specification (document) number	Name	Concerned organization
X3T13/1321D Revision 2	AT Attachment with Packet Interface-5 (ATA/ATAPI-5)	American National Standards Institute (ANSI)
SFF-8070I Revision 1.2	ATAPI Rmovavle Rewritable Media	Small From Factor Committee (SFF)
ISO/IEC 10090	90mm Optical Disk Cartridges, rewritable and read only, for data interchange.	ISO/IEC (*1)
ISO/IEC 13963	Data Interchange on 90mm Optical Disk cartridges Capacity: 230 megabytes per cartridges.	ISO/IEC (*1)
ISO/IEC 15041	Data Interchange on 90mm Optical Disk Cartridges Capacity: 640 megabytes per cartridges.	ISO/IEC JTC1 (*1)
Cherry Book	GIGAMO 1.3GB 90mm Magneto-Optical Disk System.	FUJITSU LIMITED SONY CORPORATION
Cherry Book 2	GIGAMO 2.3GB 90mm Magneto-Optical Disk System.	FUJITSU LIMITED SONY CORPORATION

*1 ISO= International Organization for Standardization

IEC= International Electrical for Commission

JTC1= Joint Technical Committee 1

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CHAPTER 1 General Description

This chapter describes the features and configuration of the optical disk drives.

The MCJ3230AP (hereafter, the optical disk drive) is the successor model to the MCE3130AP. This optical disk drive, which maintains compatibility with the MCE3130AP, offers high performance and high capacity. Supporting 2.3 GB of storage capacity, this device delivers superior performance with a 5,455-rpm rotational speed, and supports security functions.

The optical disk drive is high-performance, 90 mm (3.5-inch) commutative rewritable optical disk drive which incorporates an ATAPI controller.

The interface connecting the optical disk drive to the host system complies with the ATA/ATAPI-4.

The flexibility and expandability through ATAPI I/F, the high performance of the optical disk drive, and the drive's commands set enable the user to construct high-reliability, high-performance disk subsystems with advanced functions and large-scale storage.

1.1 Features

This section describes the following drive features:

- Performance
- Reliability
- Maintainability/operability
- Adaptability
- Interface

1.1.1 Performance

(1) Half-height standard 90 mm (3.5-inch) size (25.4 mm height)

The ATAPI controller can be directly connected to the system EIDE bus. The controller meets the specifications of the standard 25.4 mm height 90 mm (3.5-inch) fixed disk drive form factor.

(2) 2.3 GB capacity

The optical disk drive conforms to the 2.3 GB GIGAMO standard. It also supports read and write accesses to 128 MB, 230 MB, 540 MB, 640 MB, and 1.3 GB disks.

(3) High-speed data transfer

The optical disk drive supports a disk media rotational speed of 3,637 rpm when using 2.3 GB disks. The device supports a rotational speed of 5,455 rpm (ZCAV) when using a 128 MB, 230 MB, 540 MB, or 640 MB disks. When using 1.3 GB disks, the optical disk drive supports ZCAV mode with a rotational speed of 3,637 rpm, and ZCLV mode that controls the speed at three levels: 3,637/4, 138/4,801 rpm, in accordance with the position of the optical head.

In ZCLV mode, the optical disk drive speeds up by detecting continuous accessing of inner disk tracks to prevent a reduction of inner disk rotation.

For random accesses, the optical disk drive switches to ZCAV mode that is fixed to 3,637 rpm to prevent access performance degradation.

In the disk unit, high-speed data transfers at rates of 4.62 to 8.26 MB/s (2.3 GB) are realized. The data transfer rate on the EIDE bus is 16.6 MB/s in PIO mode 4, 16.6 MB/s in Multi-word DMA mode, and 33.3 MB/s in Ultra DMA Mode 2.

The EIDE bus high-speed data transfer capacity can be used effectively through the optical disk unit's large capacity data buffer.

(4) High-speed mean seek time

This drive features a linear voice-coil motor for high-speed head positioning. The average seek time is the average of 1,000 random seeks and is 19 ms. (However, this does not include command overhead or address check.)

(5) Compatible with international standards (media interchangeability)

90 mm (3.5 inch) type optical disks as well as ISO standards compatible 128 MB, 230 MB, 540 MB and 640 MB format optical disk media can be used in the optical disk unit.

(6) Direct-overwrite medium support

The drive can use an optic modulation direct-overwrite disk that does not perform an erase operation; 230-MB disk, 540-MB disk with the ISO standard.

(7) Dust resistance

The optical disk unit provides low-power consumption, eliminating the need for a cooling fan. The top of the cartridge is sealed with film, and the bottom of the optical disk unit is sealed with sheet metal, providing protection that is not complicated.

The optical disk drive needs class 5 millions or less of the dust particles.

(8) Lower power consumption

The power consumption of the optical disk drive is 5.6 W (These power consumption values are typical values during read and write operation.) These drives do not use a fan.

The minimum power consumption is 0.7 W (typical value) during power save.

(9) Automatic spindle stop function

If access is not made within a certain time, this function stops disk rotation to minimize dust accumulation on the disk. This function can be set that time by the MODE SELECT command.

1.1.2 Reliability

(1) Mean time between failures (MTBF)

This drive features a 120,000 hour MTBF.

(2) Error recovery

For the error depending on the optical disk drive, recovery process is made by a suitable retry. This drive features Reed-Solomon error correction (ECC) to assure error-free operation.

(3) Automatic allocation of alternate data blocks

This drive features a function which automatically allocates alternate data blocks to defective data blocks detected while data is being read from or written to an optical disk.

1.1.3 Maintainability/operability

(1) Diagnostic function

This drive has a diagnostic function to check optical disk drive operations. The diagnostic function facilitates test and restoration.

(2) Five-year service life (no overhaul)

This drive will not require overhaul within the first five years of installation if appropriately handled, maintained, and cleaned as recommended.

1.1.4 Adaptability

(1) Wide operating environment

An LSI circuits reduce power consumption. This drive features a wide operating environment (5 to 45°C, general office environment). Dust particles are class 5 millions or less.

(2) Vibration resistance (shock resistance)

Rubber vibration isolators protect the drive against external shock or vibration.

(3) Safety standards

- UL1950 (U.S.A., safety)
- CDRH class 1 (U.S.A., laser)
- CSA C22.2 No. 950 (Canada, safety)
- EN60950 (Europe, safety)
- EN60825 Class 1 (Europe, laser)

(4) Various radio wave standards

This optical disk device is installed in a host system, and meets the following standards:

- EN55022 class B, EN55024 (European wave standards)
- AS/NZS3548 class B (Australian wave standards)
- CNS13438 (Taiwanese radio interference standard)

1.1.5 Interface

(1) ATA/ATAPI-4

This drive supports the basic ATA/ATAPI-4 specifications.

ATAPI commands enable operation using logical block addresses that are independent of the physical attributes of the drive, enabling software flexibility in terms of system expansion.

Supports PIO Mode 4 Multi-word DMA Mode 2, and Ultra DMA Mode 2.

(2) Continuous block processing

Logical block addresses are used for data block addressing. Without consideration of the physical attributes of track boundaries, the host can access data by specifying a block number in logically continuous data space.

(3) Data buffer

7,600 KB buffer is used to transfer data between the EIDE bus and disk. Since data is stored in this buffer, the host can execute input-output processing effectively by using the high-speed data transfer capability of the EIDE bus without regard to the data transfer rate of the optical disk drive.

(4) Read-ahead cache feature

The read-ahead cache feature enables high-speed sequential data access as follows:

After executing a command to read data from the disk, the drive automatically reads the next data block and stores it in the data buffer (pre-reading). If the next command requests this data, the data is transferred from the buffer without another disk access.

(5) Write cache feature

When the host system issues the write command to the optical disk drive, a command complete is usually responded after completion of the write and verify operations. By using the write cache feature, a command complete is responded after completion of the data transfer to the data buffer without waiting the completion of the write and verify operations then the write and verify operations are made asynchronously with the interface operation. Therefore, the apparent write command processing time measured at the host system is reduced and the I/O performance of the host system is improved.

The write cache feature is enabled or disabled by MODE SELECT command.

IMPORTANT

When the write cache feature is enabled, a write error is reported at the completion status of next command. At a system so that the host retries the command, a retry process may be failed.

(6) Defective block slipping

When a disk is initialized, logical data blocks are reallocated in a physical sequence by slipping defective data blocks. This enables high-speed continuous data block processing without rotational delay due to defective data blocks.

(7) Device driver software

The optical disk drive requires more extended processing time than conventional optical device drives because of higher density. Consequently, a processing time timeout when using the OS can occur and this requires special device driver software.

1.2 Drive Configuration

1.2.1 Drive model

Figures 1.1 and 1.2 show the outer view.

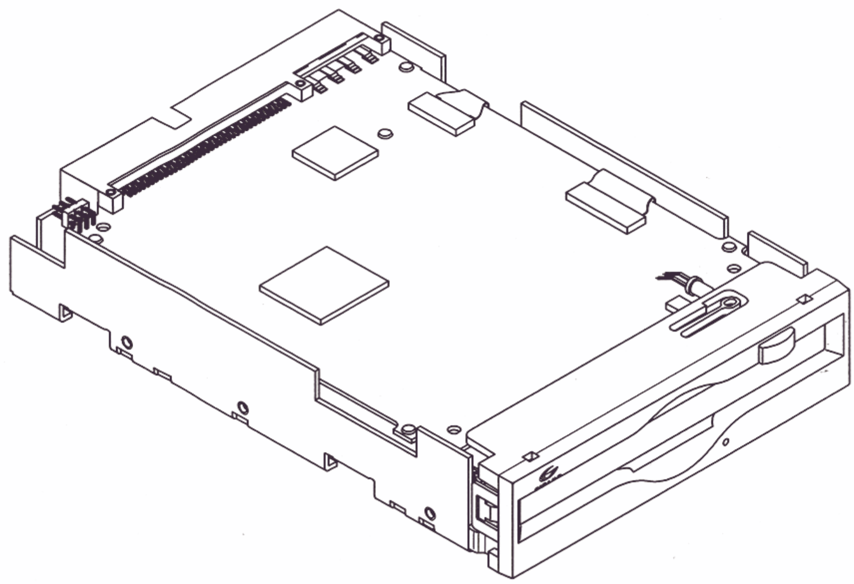


Figure 1.1 Outer view (with panel)

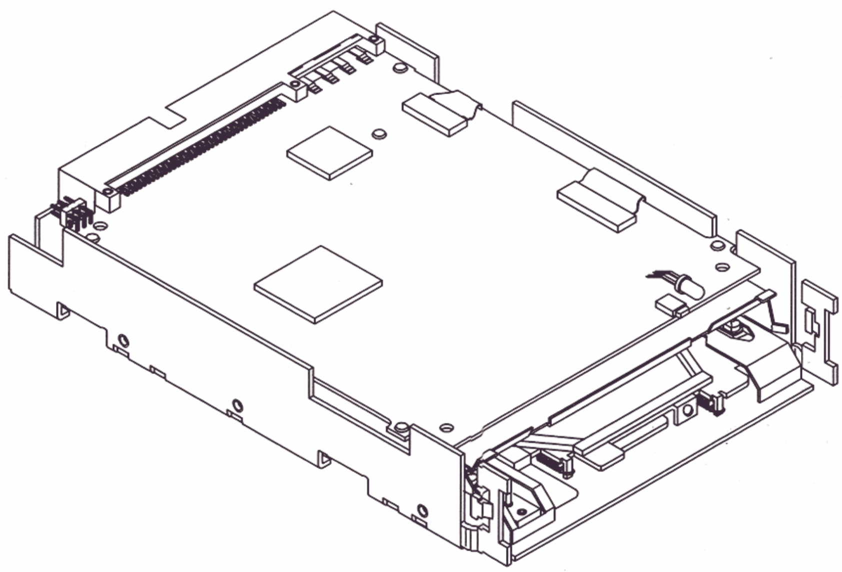


Figure 1.2 Outer view (without panel)

1.2.2 Configuration

Figure 1.3 shows the drive configuration.

The drive consists of mechanical sections, a fixed optics section, actuator, and a control circuit section. The mechanical sections include the spindle motor, actuator section, bias magnet, and the cartridge folder vertical motion mechanism.

The fixed optics section consists of the optical components, position detector, and LD controller.

The control circuit sections include the drive control circuit section and ATAPI controller section.

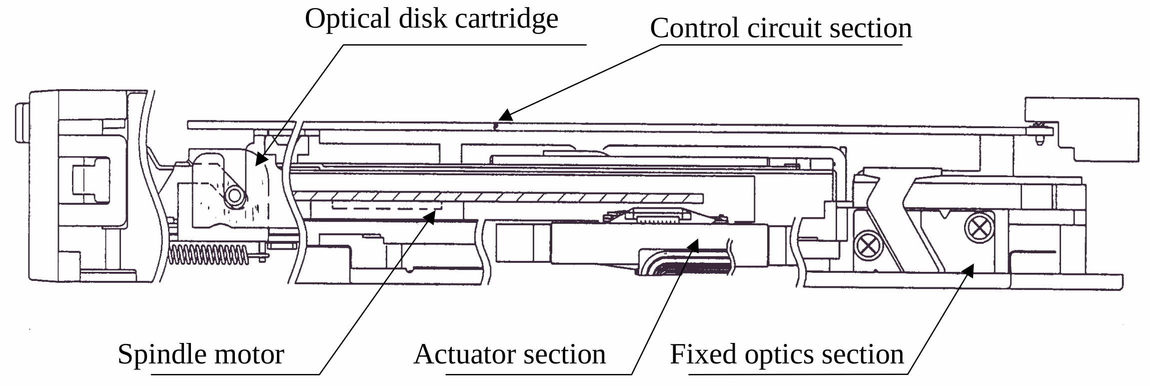


Figure 1.3 Optical disk drive configuration

1.2.3 Mechanical sections

(1) Optical disk cartridge load/eject

The system includes a cartridge mechanism which lowers the optical disk cartridge and mounts (loads) it on the spindle motor automatically when the optical disk cartridge is fully inserted in the optical disk drive's disk slot, and a mechanism which automatically ejects the cartridge when the Eject button on the front panel is pressed.

(2) Spindle motor

Optical disk cartridge hubs are linked through magnetic clamps to minimize slippage between the spindle motor shaft and disk. The spindle motor is the direct drive type which rotates the disk at the same speed as the spindle motor shaft. A DC brushless spindle motor is used. The spindle motor rotates at 5,455 rpm ± 0.1%.

(3) Actuator section

The positioner moves (seeks) a head actuator radically across the disk surface.

The positioner is driven by a linear voice coil motor. A pulse-width modulation (PWM) is adopted as a driving system and realizes low power consumption and high-speed access.

(4) Separate optical sections

The optical head section is separated in such a way that the fixed optics section is separated from the moving optics section to minimize seek time and positioning error. (See Subsection 1.2.4 for the fixed optical section.) This reduces the weight of the moving parts.

The fixed optics section consists of the laser diodes, collimator lens, and optical detector.

The fixed optics section includes a laser diode for recording and playback, and transmits one laser beam to the head actuator.

(5) Panel

The central part of the panel is hollowed out deeply to provide pushing finger space for inserting the cartridge, thereby facilitating the insertion.

The panel is also simply designed by making the eject button and LED light emitting part integral with each other.

1.2.4 Control circuit section

Figure 1.4 is the block diagram of the control circuit section.

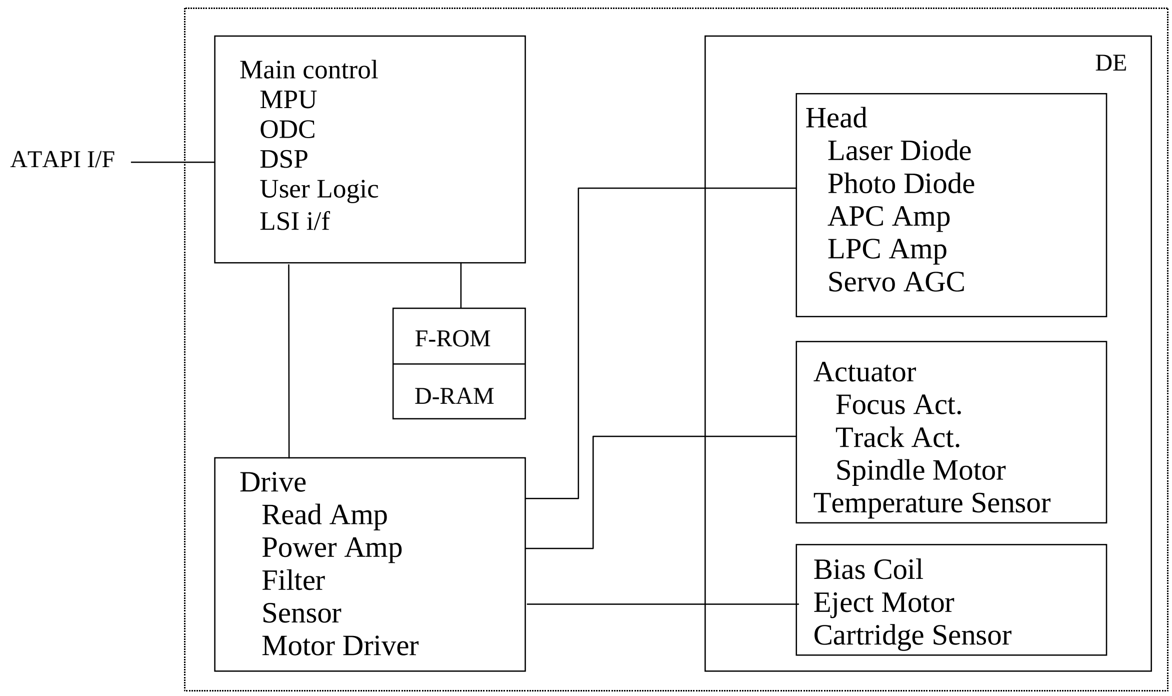


Figure 1.4 Control circuit section block diagram

The control circuit section is divided into two parts: an ATAPI controller section which deals with control between the ATAPI interface and drive interface, and a drive circuit section which controls the drive.

(1) ATAPI controller circuit section

The ATAPI controller circuit's reliability is improved by large-scale integrated circuit technology. The high-speed microprocessor (MPU) handles ATAPI interface control and drive control such as drive read-and-write control and single-beam control.

(2) Drive circuit section

The drive circuit section consists of the following circuits:

- Laser diode control circuit
- Signal reproduction circuit
- Servo/seek control circuit
- Rotation control circuit
- Drive miscellaneous control circuit

The DSP (digital signal processor) is used for the servo/seek control circuit to reduce the circuit amount, therefore this circuit is a simple configuration.

The drive circuit section executes operations such as seek, erase, record, and playback while the MPU controls the focus-tracking of the beam.

1.3 System Configuration

Figures 1.5 and 1.6 show the PC AT interface system configuration. The interface can be directly connected to the 40-pin AT-compatible IDE interface.

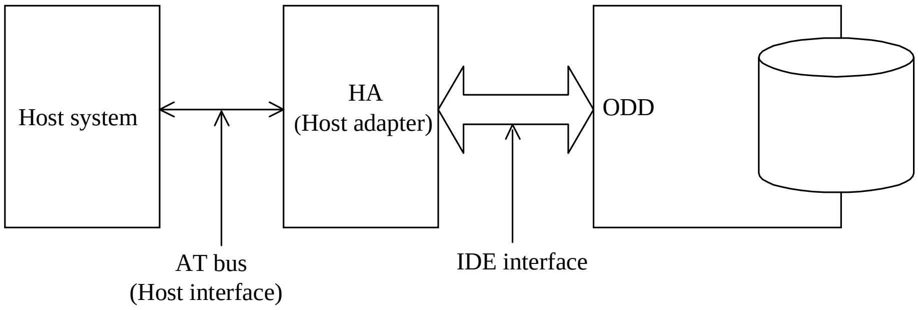


Figure 1.5 System configuration with one optical disk drive

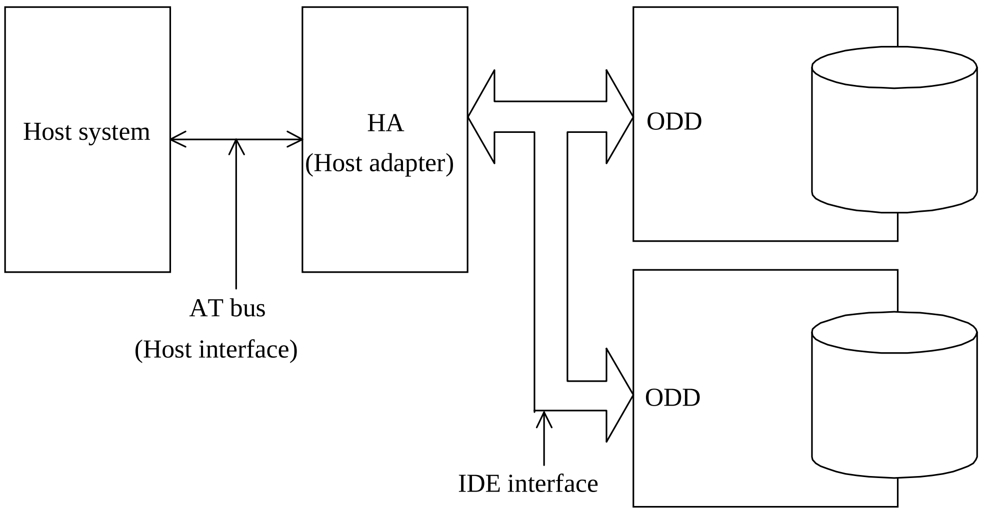


Figure 1.6 System configuration with two optical disk drives

IMPORTANT

The PC AT interface will not meet the specification if two optical disk drives not conforming to the ATA are connected.

The host adapter (HA) consists of an address decoder, driver, and receiver. ATA stands for AT Attachment. This drive supports the ATA interface.

CHAPTER 2 Specifications

This chapter contains the specifications of the optical disk drive, and the optical disk cartridge.

2.1 Optical Disk Drive Specifications

2.1.1 Model and product number

Table 2.1 lists the model and order number.

Table 2.1   Model and order number

Model Name	Order No.	Panel	Panel Color	Mounting Screws
MCJ3230AP	CA05890-B501	with panel	Light gray (2.5Y 7.2/0.4)	Metric screws (M3)
	CA05890-B701	without panel	—	Metric screws (M3)
	CA05890-B601	with panel	Light gray (2.5Y 7.2/0.4)	Metric screws (M3)

Note: The panel colors (2.5Y 7.2/0.4) are indicated in Munsell symbols. (JIS Z8721)

2.1.2 Drive specifications

Table 2.2 lists MCJ3230AP drive specifications

Table 2.2 Specifications (1 of 2)

[MCJ3230AP]

Item		Specifications					
Optical disk cartridge		128 MB media	230 MB media	540 MB media	640 MB media	1.3 GB media	2.3 GB media
Total capacity	Unformatted	181 MB	325 MB	819 MB	818 MB	1.683 GB	2.901 GB
	Formatted	128 MB	230 MB	538 MB	643 MB	1.283 GB	2.261 GB
Capacity/track	Unformatted	18,100 bytes	18,100 bytes (logical track capacity)	19,450 bytes (logical track capacity)	43,928 bytes (logical track capacity)	45,798 bytes (logical track capacity)	47,022 bytes (logical track capacity)
	Formatted	12,800 bytes	12,800 bytes (logical track capacity)	12,800 bytes (logical track capacity)	34,816 bytes (logical track capacity)	34,816 bytes (logical track capacity)	34,816 bytes (logical track capacity)
Capacity/sector	Unformatted	725 bytes	778 bytes	778 bytes	2,584 bytes	2,694 bytes	2,766 bytes
	Formatted	512 bytes			2,048 bytes		
Number of user tracks/side (*1)		10,000	17,940	42,042	18,480	36,855	64,944
Number of alternate sectors/side		≤ 1,024	≤ 1,025	≤ 2,250	≤ 2,244	≤ 4,437	≤ 8,976
Number of sectors/track		25			17		
Data transfer rate		1.65 MB/s (max.) 0.39 MB/s continuous writing (effective) 1.16 MB/s continuous reading (effective)	2.00 to 3.16 MB/s (max.) 0.47 to 0.75 MB/s continuous writing (effective) 1.40 to 2.23 MB/s continuous reading (effective)	3.45 to 5.94 MB/s (max.) 0.78 to 1.30 MB/s continuous writing (effective) 2.33 to 3.91 MB/s continuous reading(effective)	3.52 to 5.87 MB/s (max.) 0.93 to 1.55 MB/s continuous writing (effective) 2.79 to 4.66 MB/s continuous reading (effective)	3.92 to 6.70 MB/s (max.) 0.99 to 1.70 MB/s continuous writing (effective) 2.98 to 5.09 MB/s continuous reading (effective) 5.17 to 6.70 MB/s (ZCLV max.) continuous writing (ZCLV effective) 1.31 to 1.70 MB/s continuous reading (ZCLV effective) 3.93 to 5.09 MB/s	4.69 to 8.38 MB/s (max.) 1.16 to 2.07 MB/s continuous writing (effective) 3.84 to 6.21 MB/s continuous reading (effective)
Random seek time (*2)		19 ms (typ)					
Average latency		5.5 ms				8.2 ms 7.2 ms (ZCLV) 6.3 ms (ZCLV)	8.2 ms
Rotational speed		5.455 rpm				3,637 rpm 4,138 rpm (ZCLV) 4,801 rpm(ZCLV)	3,637 rpm
Heads		Positioner + Separete Optical Section					
Positioner type		Linear voice coil motor					
Servo tracking method		ISO continuous servo method					

Table 2.2 Specifications (2 of 2)

[MCJ3230AP]

Item	Specifications					
Optical disk cartridge	128 MB media	230 MB media	540 MB media	640 MB media	1.3 GB media	2.3 GB media
Density	24,424 bpi (1.04µm/bit) 15,875 tpi	29,308 bpi (0.87µm/bit) 18,275 tpi	52,900 bpi (0.48µm/bit) 23,090 tpi		89,100 bpi (0.285µm/bit) 28,200 tpi	112,474 bpi (0.228µm/bit) 37,910 tpi
Loading time (*3)	8 sec. (typ)				12 sec. (typ)	20 sec. (typ)
Unloading time (*4)	4 sec. (typ)					
Load/unload life	20,000					
Host interface	ATAPI (ATA/ATAPI-4 standard)					
Data Transfer Model and rates	PIO Mode 4 16.6 MB/s Multi-word DMA Mode 2 16.6 MB/s Ultra DMA Mode 2 33.3 MB/s					
Data buffer	7,600 KB					
Error correction (*5)	Correctable up to 8-byte/interleave Bit error rate: 10^{-12} or less					

*1 The number of user tracks indicates the maximum user zone which includes the spare area and slipping area.

*2 Mathematical average of 1,000 times of seek and does not include command overhead nor track address recognition time. Furthermore, it may depend on the quality of media and drive installation environment.

*3 Loading time is the time from when the optical disk cartridge is inserted to when the optical disk drive is ready.

*4 Unloading time is the time from when the eject button is pressed or the eject command is issued to when the optical disk cartridge is ejected.

*5 The bit error rate must be 10^{-12} or less when a disk whose raw error rate is 10^{-4} or less is used.

2.1.3 Environmental and power requirements

Table 2.3 lists the environmental and power requirements.

Table 2.3 Environmental and power requirements (1 of 2)

Item		Specification
Power requirements	Average	+5 VDC±5%, 1.4 A (2.5 A Max.) (*1) Ripple requirement 100mV P-P (DC-1 MHz)
Power consumption (Average)	Ready (active mode)	4.3 W (typical) (*2)
	Random seek, read/ write	5.6 W (typical) (*2)
	Physical Format	7.0 W (typical) (*2)
	Power save mode Pre-idle mode Idle mode Standby mode Sleep mode	 3.8 W (typical) (*2) 1.3 W (typical) (*2) 0.7 W (typical) (*2) 0.7 W (typical) (*2)
Dimensions (W×D×H)	With panel	101.6 × 150.0 × 25.4 mm
	Without panel	101.6 × 148.4 × 25.4 mm
Weight		480 g (with panel)
Environmental requirements	Operating	Temperature: 5 to 45°C (*3) (gradient 15°C /h or less) Relative humidity: 10 to 85% (Noncondensing) Max. wet bulb temperature: 29°C or lower
	Non Operating	Temperature: 0 to 50°C Relative humidity: 10 to 85% (Noncondensing) Max. wet bulb temperature: 36°C or lower
	Transport	Temperature: -40 to 60°C (24 hours or less) Temperature: -20 to 60°C (24 hours or more) Relative humidity: 5 to 90% (Non condensing) Max. wet bulb temperature: 41°C or lower
Installation	Tilt angle	-5° to +10° (*3)
Vibration/ shock	Operating	3.9 m/s^2 (5 to 500 Hz, sine sweep) 1.96 m/s^2 (5 to 500 Hz, sine sweep AV record/play) Shock 19.6 m/s^2 (10ms, half-sine pulse)
	Non Operating No cartridge, power ON	9.8 m/s^2 (5 to 500 Hz, sine sweep) Shock 49 m/s^2 (10 ms, half-sine pulse)
	Transport	Shock 490 m/s^2 (10 ms, half-sine pulse) Requirement: Packing conditions specified by Fujitsu

Table 2.3 Environmental and power requirements (2 of 2)

Item		Specification
Altitude	Operating	3,000 m (10,000 ft) or less
	Non Operating	12,000 m (40,000 ft) or less
Ambient for purity	Air flow	Unused (*4)
	Air purity	General office environment or better (dust perticles: Class 5 millions or less)

Note:

*1 At random seek or read/write. Excluding pulse waveform under 500 us or less.

*2 It demonstrates in an installation environment of a temperature of 25°C, voltage of 5 V.
See Section 4.4.8 for information on the power management function.

*3 The efficiency is specified in an environment of a temperature of 25°C and 0° horizontal level placement.

*4 For details, refer to section 3.1.3 'Air Flow'

1. Current limiter value for +5 VDC power: 5 A or less
2. Specifications under transporting condition are under the packaging specified by Fujitsu.
3. A voltage drop may occur depending on the used power supply or power cable.

2.1.4 Error rate

Data blocks to be accessed are evenly distributed on the disk. Errors due to disk defects are not included.

(1) Bit error rate after ECC processing

The error rate after ECC processing must be 10^{-12} or less. An optical disk cartridge whose raw error rate is 10^{-4} or less should be used.

(2) Positioning error rate

The positioning error rate must be 10^{-6} or less. (with retry)

2.1.5 Reliability

(1) Mean time between failures (MTBF)

The MTBF is 120,000 hours or more. Failure due to disk errors is not included.

Conditions

- Power-on time: 200 hours/month or less
- LD-on time: 20% or less of power-on time
- Environment Temp.: 25°C

Note:

The MTBF is defined as follows:

$$\text{MTBF} = \frac{\text{total operating time in all fields (hours)}}{\text{number of device failure in all fields}}$$

1) Operating time is the total time power is applied.

2) Device failures indicate that devices require repair, readjustment, or replacement. Failure due to external factors such as minor defects during device handling, operation outside environmental specifications, power failure, host system errors, and interface cable errors are not included.

(2) Service Life

Under appropriate handling and operation, disk cleaning and optical head cleaning, overhaul of the drive is not required for the first five years.

(3) Data security at power failure

Except for the data of the block to which write operation is in progress, all data on the disk is secure from power failure. This does not apply if power failure occurs during disk initialization (formatting) or defect processing (alternate block allocation).

2.2 Optical Disk Cartridge Specifications

2.2.1 Recommended optical disk cartridge specifications

The following three disk types comply with the specifications.

Table 2.4 shows the specifications of the optical disk cartridge recommended for this optical disk drive. The use of another disk cartridge may lower drive performance.

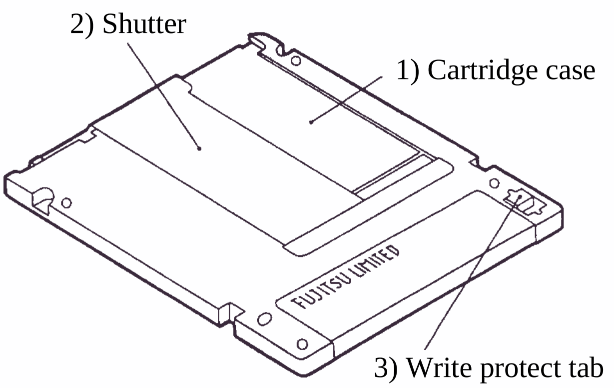
Table 2.4 Recommended optical disk cartridge specifications

Model	Order number	Figure number
Optical disk cartridge (128 MB)	0242110	CA90002-C010
Optical disk cartridge (230 MB)	0242210	CA90002-C011
Optical disk cartridge (540 MB)	0242410	CA90002-C012
Optical disk cartridge (640 MB)	0242610	CA90002-C013
Optical disk cartridge (1.3 GB)	0242810	CA90002-C015
Optical disk cartridge (2.3 GB)	0242910	CA90002-C030
Overwrite optical disk cartridge (230 MB)	0242310	CA90002-C041
Overwrite optical disk cartridge (540 MB)	0242510	CA90002-C042
Overwrite optical disk cartridge (640 MB)	0242710	CA90002-C043

2.2.2 Optical disk cartridge

Figure 2.1 shows an optical disk cartridge. The figure below shows the cartridge with its shutter open.

- Shutter closed



- Shutter open

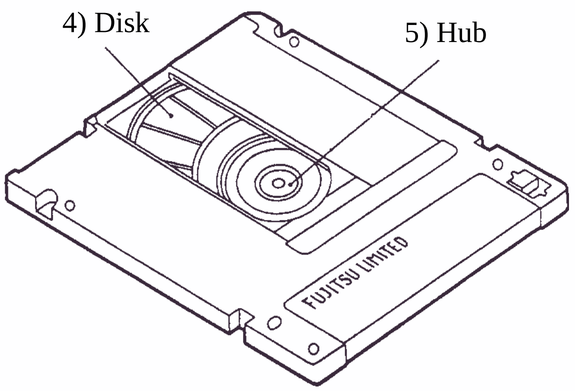


Figure 2.1 Optical disk cartridge

The following explains the components of the optical disk drive shown in Figure 2.1:

1) Cartridge case

   Covers the disk to protect it from damage when handled and facilitates disk replacement. The cartridge case is labeled and has a write protect tab.

2) Shutter

   Protects the disk against dust. When the cartridge is inserted into the optical disk drive, the shutter (metallic door) is opened.

3) Write protect tab

   The write protect tab selects whether write is enabled or disabled.

4) Disk

   Holds information which can be read by an optical beam.

5) Hub

   The hub is placed at the center of the disk and is linked to the spindle of the drive. The hub is used for radial centering and axial positioning.

2.2.3 Disk specifications

(1) 128 MB disk

The ISO/IEC10090 defines 128 MB disk specification.

(2) 230 MB disk

The ISO/IEC13963 defines 230 MB disk specification.

(3) 540 MB/640 MB disk

The ISO/IEC15041 defines 540 MB/640 MB disk specification.

(4) 1.3 GB disk

The Cherry Book defines 1.3 GB disk specification.

(5) 2.3 GB disk

The Cherry Book 2 defines 2.3 GB disk specification.

Table 2.5 lists disk specifications.

Table 2.5 Disk specifications

Item		Specification
Reliability	Read cycle	$>10^8$
	Erase/write/read cycle	$>10^6$
	Load/unload cycle	25,000
	Archival life (according to acceleration test results)	>10 years (*1)
	Shelf life (according to acceleration test results)	>10 years (*2)
Environmental requirements	Operating temperature	5 to 55°C
	Operating relative humidity	3 to 85%RH (*3)
	Storage temperature	-20 to 55°C
	Storage humidity	3 to 90% RH (*3)

*1 Archival life is the period in which recorded information can be read.

*2 Shelf life is the period in which information to be recorded can be written.

*3 Maximum wet bulb temperature = 29°C.

Note:

Non-recommended disks must be checked for compatibility.

2.3 Defect Management

2.3.1 Defect management schematic diagram

Defective sectors on the disk shall be replaced by good sectors according to the defect management scheme as follows: Defective sectors found during surface certification are handled by a sector slipping algorithm. Defective sectors found after initialization are handled by a linear replacement algorithm.

Figure 2.2 shows the algorithms for alternate processing.

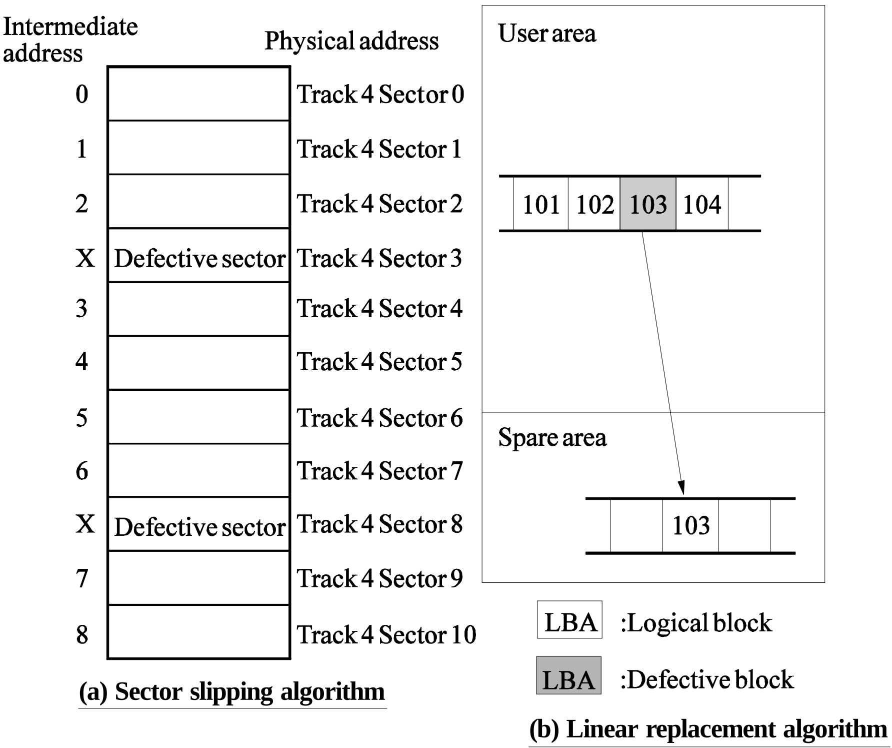


Figure 2.2 Algorithms for alternate processing

The user area is divided into several groups during media initialization. Each group contains data sectors and spare sectors. Spare sectors are used as replacements for defective data sectors. Media initialization can include a certification of the user area.

Figure 2.3 shows an example of alternate processing.

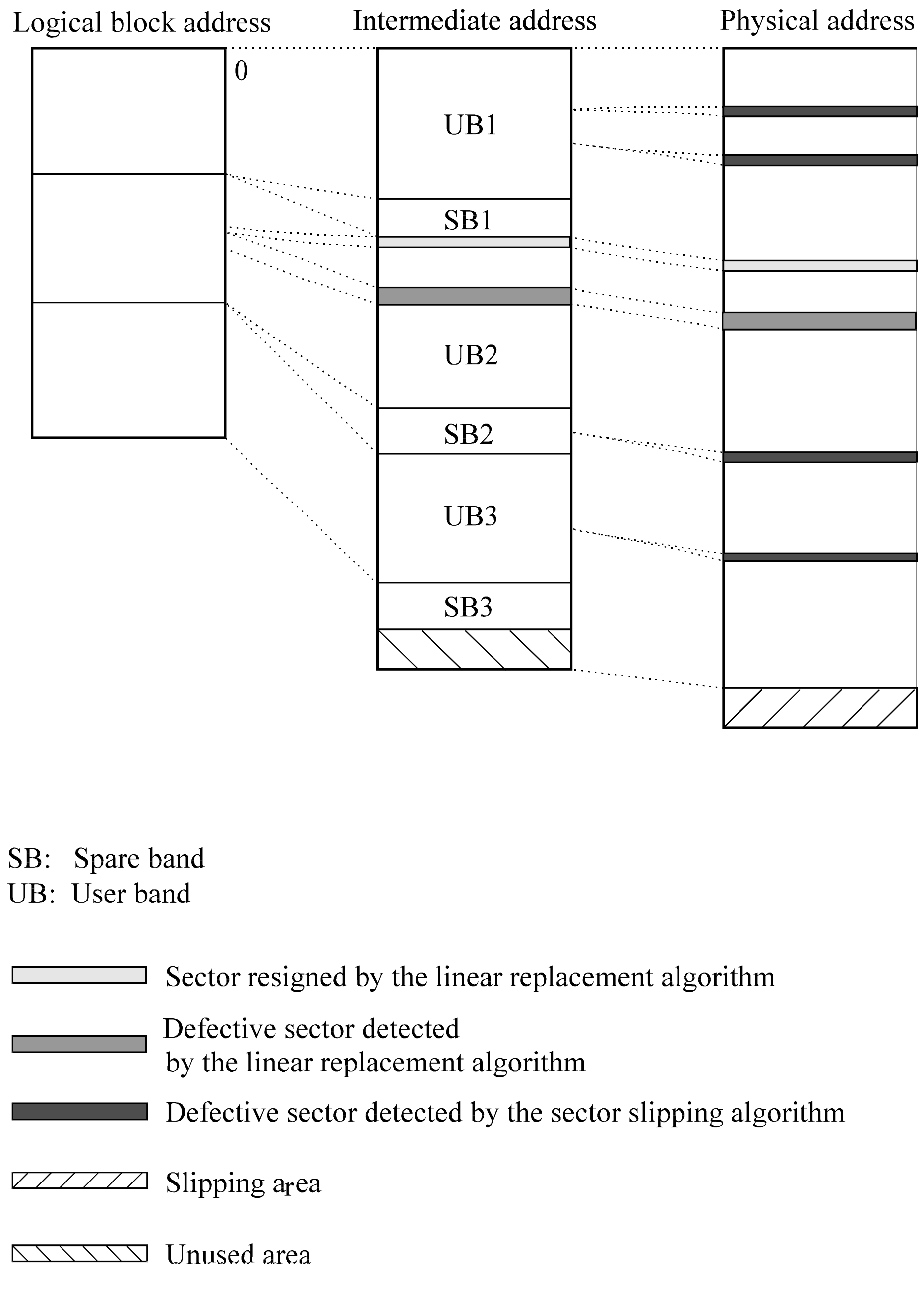


Figure 2.3 Example of alternate processing

CHAPTER 3 Installation Requirements

This chapter describes environmental, mounting, power supply, and connection requirements.

3.1 Environmental Requirements

The environment in which these drives are installed must comply with the ambient environmental requirements defined in Subsection 2.1.3.

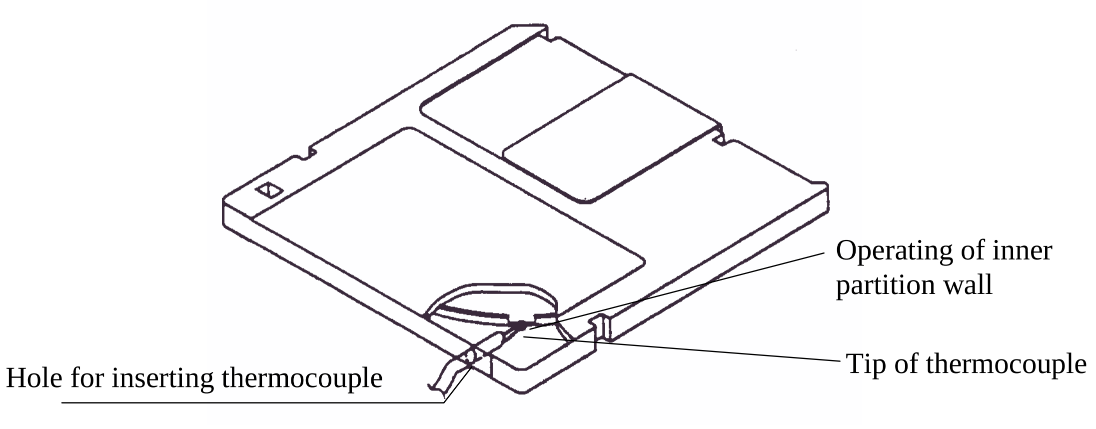
3.1.1 Temperature measurement point

When a drive is operating, the ambient temperature measured 3 cm from the base surface of the optical disk drive and the PCA unit surface must satisfy the environmental requirements specified in Subsection 2.1.3. For the temperature of each surface during operation, the contact temperature at each measurement point shown in Figure 3.1 must satisfy the requirements specified in Subsection 3.1.2.

CAUTION

Low temperature burns: The surface temperatures of some ICs on the printed circuit board unit in the optical disk drive exceed 55°C while operating. Be careful of low tenperature burns.

(a) Inside optical disk cartridge



(b) IC (controller, read amp)

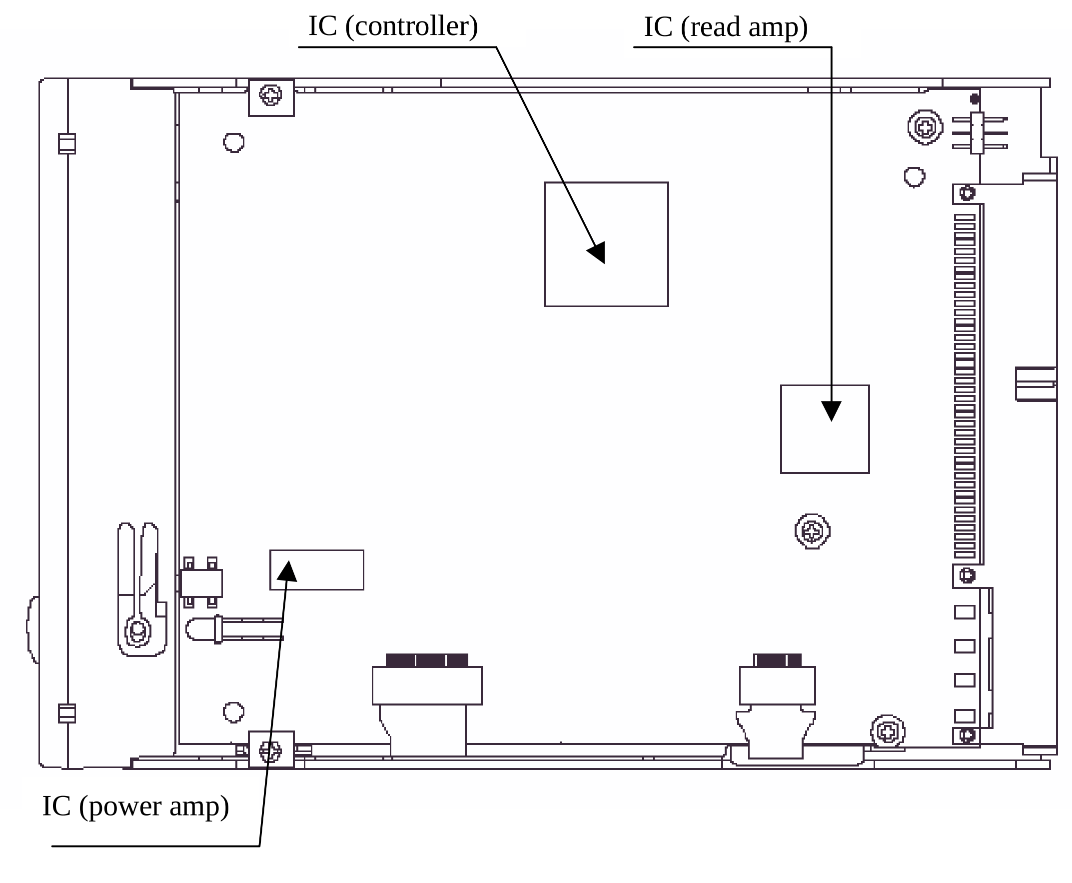


Figure 3.1 Surface temperature measurement points

3.1.2 Temperature requirements and measuring method

Table 3.1 shows the temperature requirement at each measurement point shown in Figure 3.1.

Table 3.1 Temperature requirements at measurement points

Measurement point	Maximum surface temperature
Cartridge inside	55°C (*)
IC (controller) surface	90 °C
IC (read amp.) surface	95 °C
IC (power amp.) surface	90 °C

Following procedure is for temperature measurement of inside cartridge.

1) Make a hole for the thermocouple as shown in Figure 3.1.

2) Disassemble the cartridge disk.

3) Cut off a part of the partition wall for the optical media as shown in Figure 3.1. (Cut off width: 5 to 10 mm)

4) Fix the tip of the thermocouple to the cut portion of partition wall with an adhesive agent.

5) Pass the thermocouple through the hole at the cartridge case and assemble the cartridge disk. When there is a gap between the hole and the thermocouple, fill the gap with the adhesive agent.

Note:

The surface of the cartridge shown in Figure 3.1 has been cut away to make the elements inside the case clearly visible. In reality the surface is not cut away.

If the external environment temperature is higher than the specified value, the device will automatically take an interval to respond to command, and then take protective action to respond to the temperature increase.

3.1.3 Air flow

It is recommended that this optical disk drive be installed in a fanless cabinet. However, if the power supply is incorporated into the same cabinet, it is necessary that it satisfy the "Temperature Conditions" in 3.1.2 and that the air flow rate being drawn in by the device) at the cartridge loading slot be 0.3 m/s or lower. Furthermore, if there is a system fan in a system where this drive is being installed, the same conditions must be met.

3.1.4 Temperature rise under several conditions

Table 3.2 Temperature at each measuring point (Reference)

[Ambient atmospheric temperature of the optical disk drive: 45°C] (°C)

Measurement point	Ready	Random seek	Criteria
Inside cartridge	47°C	54°C	55°C
IC (controller) surface	51°C	68°C	90°C
IC (read amp.) surface	48°C	90°C	95°C
IC (power amp.) surface	47°C	78°C	90°C
Thermal sensor	47°C	55°C	–

Notes:

1. The above data are data estimated as they were measured where the temperature surrounding the equipment was kept at 45 °C, using that at 25 °C. They are not the same as the data obtained from measurements using the exclusive box in which the equipment is normally used.
2. When using the box, the ambient temperature around the equipment will differ depending on the air circulation conditions of the box, and the temperature rise inside the cartridge will differ because of this, so please exercise caution.

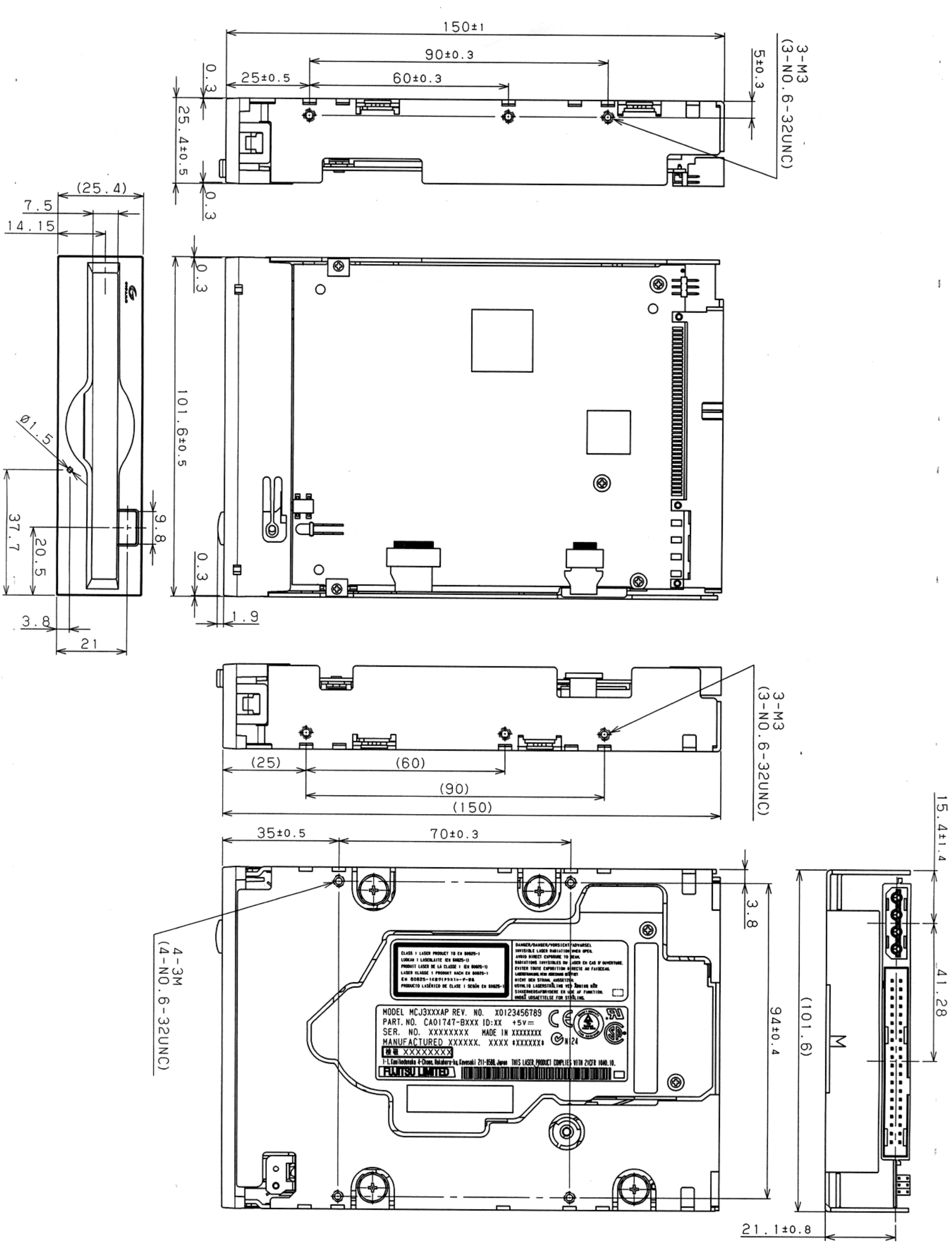
3.1.5 Air purity

Air purity in the device environment is expressed by the number of dust particles per unit area and must be class 5 millions (equivalent to 0.15 mg/m^3) or less. (Class 5 millions: 5 millions dust particles of 0.5 um dia. or larger per cubic foot)

3.2 Mounting Requirements

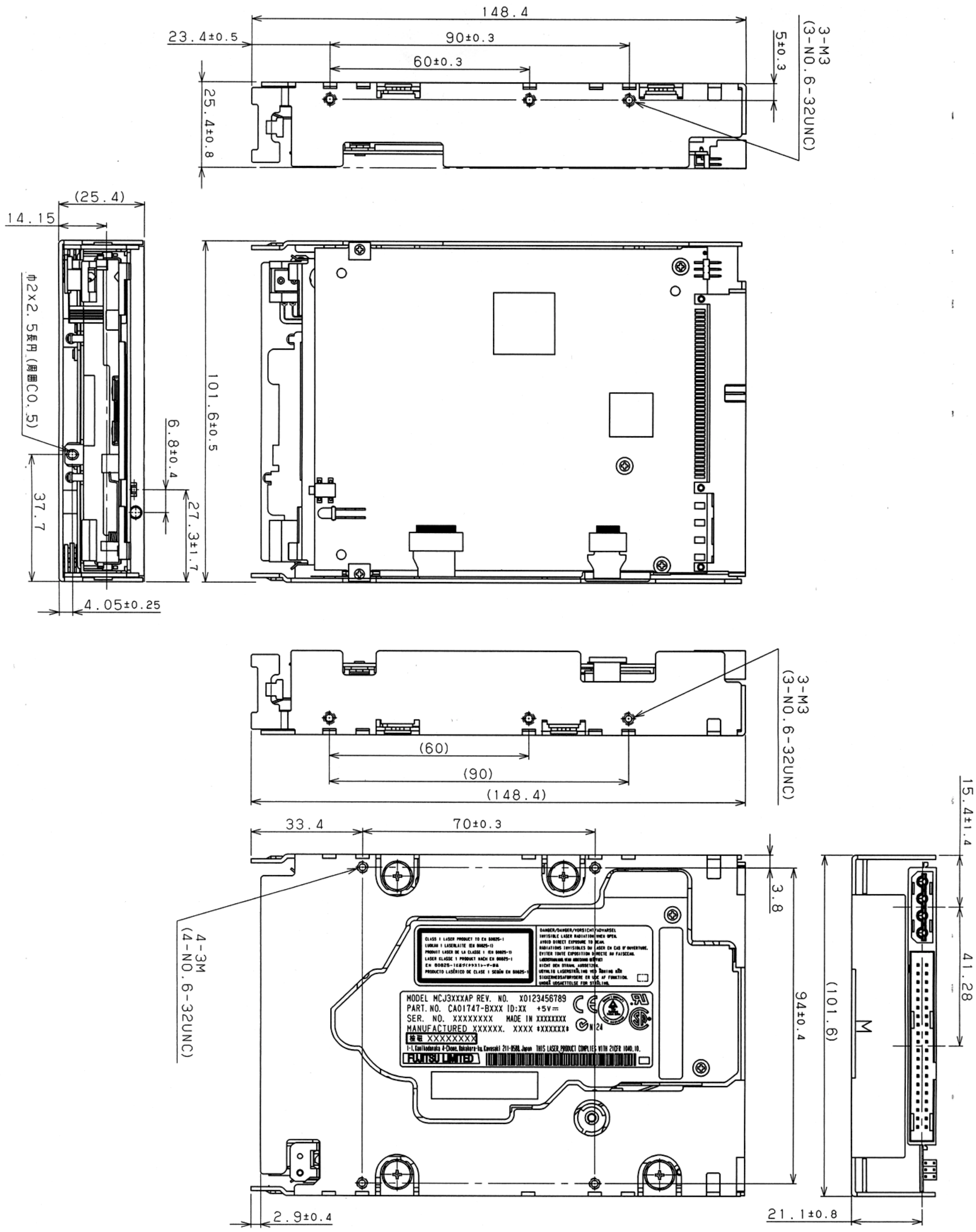
3.2.1 External dimensions

Figures 3.2 to 3.3 show the dimensions of the drive and the positions of the mounting holes.



Unit: mm

Figure 3.2 Dimensions

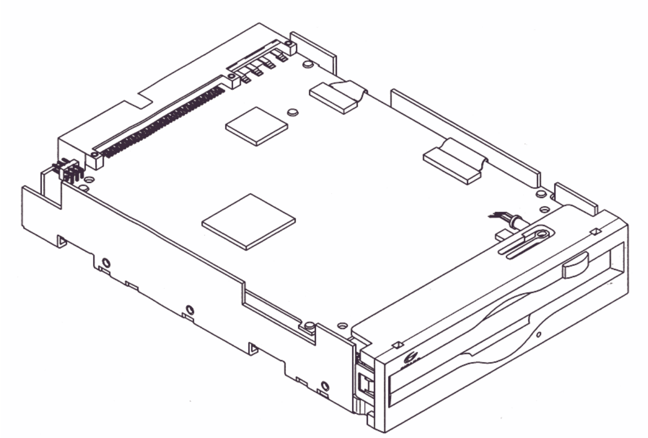


Unit: mm

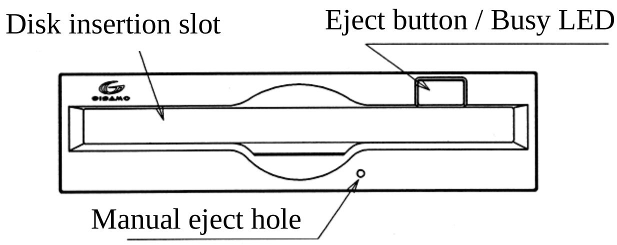
Figure 3.3 Dimensions (without panel)

3.2.2 Installation direction

Figure 3.4 shows the permissible installation directions for this drive. The mounting angle tolerance must be within -5 to 10 from the horizontal. (-) shows that the insertion faces below.



- Horizontal



- Vertical
  (Two orientations)

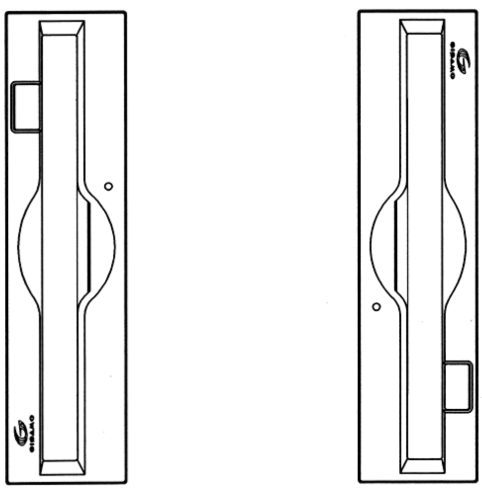


Figure 3.4 Installation directions

3.2.3 Centers of gravity

Figure 3.5 shows the centers of gravity of the drive.

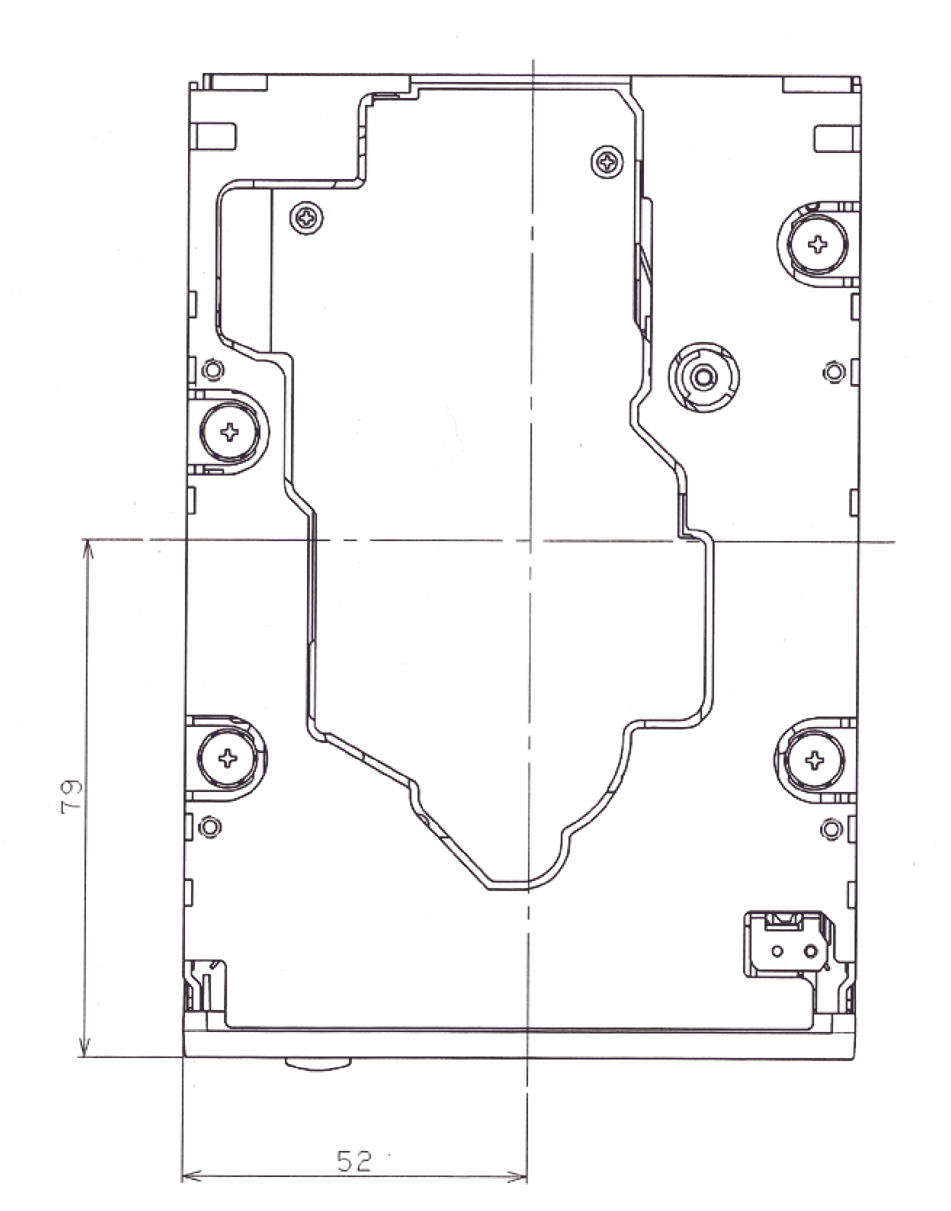


Figure 3.5 Centers of gravity

3.2.4 Notes on mounting

(1) Mounting frame structure and clearance

a) For vibration resistance and heat dissipation, this optical disk drive uses an embossed structure as shown in Figure 3.6, as well as a frame which has a construction similar to other frames which perform the same function.

b) As shown in Figure 3.6, the inward projection of the mounting screw from the outer surface of the drive frame must not exceed 3 mm.

c) The clearance between the external surface of the drive frame and the user's frame structure must be at least 1.5 mm.

d) The clearance between the top and bottom surfaces and the user's frame structure must be at least 1.5 mm.

e) When mounting the optical disk drive, the screw tightening torque should be 0.4 to 0.45Nm (4 to 4.6kgcm).

f) When the optical disk drive (with panel) is mounted in a locker, there should be no deformation of the mounting fittings provided and the optical disk drive's panel should not be deformed. If the drive is used with the panel deformed, ejection of the cartridge will be faulty. Check if the door will close from any position whatever when the optical disk drive is installed.

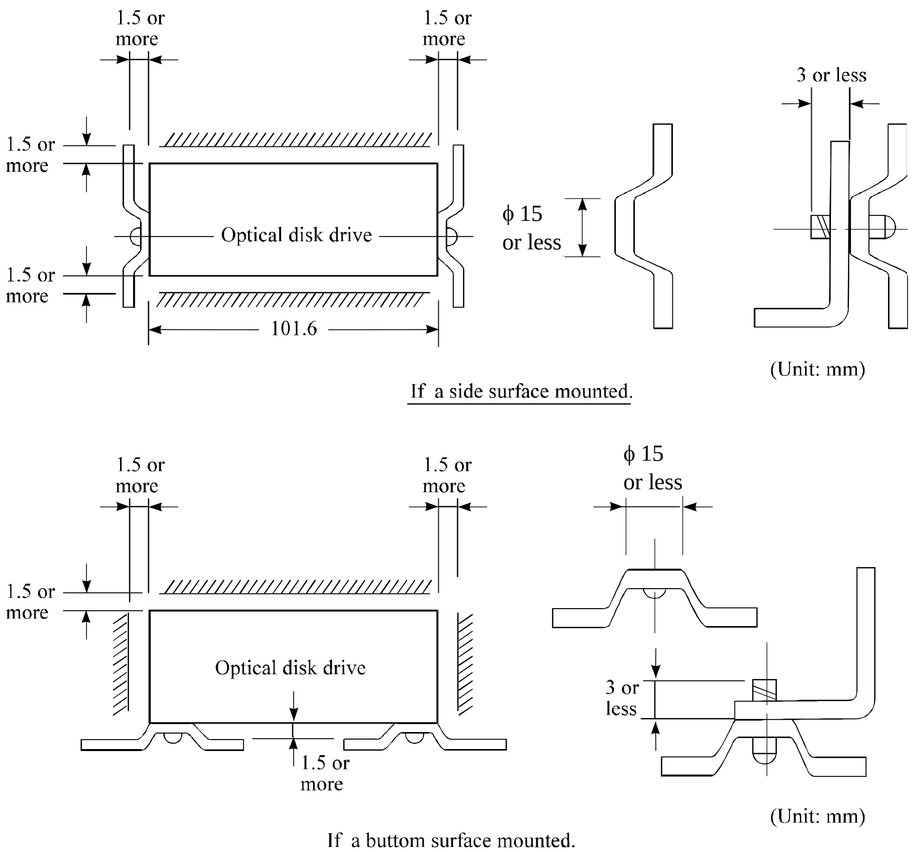


Figure 3.6 Mounting frame structure

(2) Panel function processing

When installed in a cabinet, do not change the panel formal. The processing is installation status and the disk insertion door can be closed from any locations.

(3) Service clearance

Figure 3.7 shows locations which must be accessed for installation and maintenance. Be sure to leave sufficient service clearance.

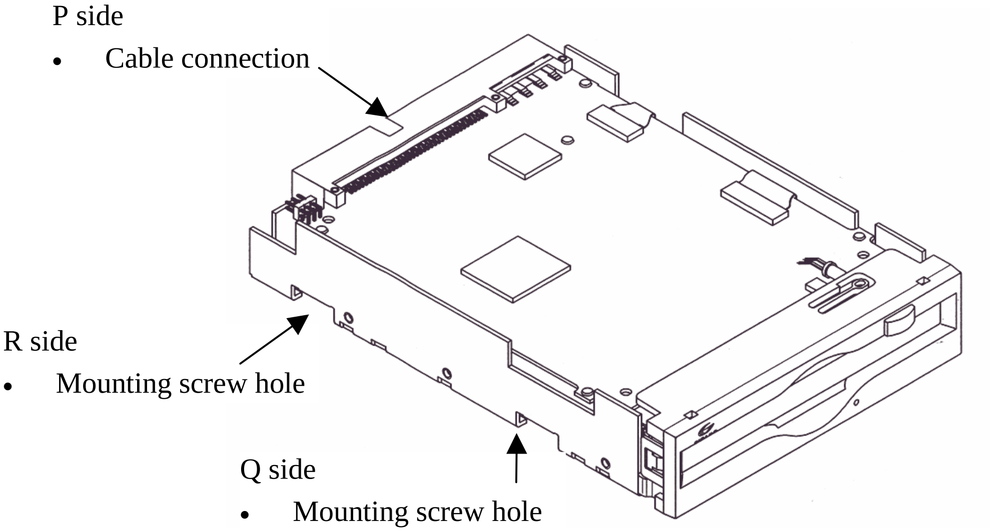


Figure 3.7 Service clearance

(4) External magnetic fields

Mount the optical disk drive away from powerful magnetic materials (e.g., a speaker) to avoid influence from magnetic fields.

(5) Leak magnetic field

The VCM drive magnetic circuit may leak the magnetic field (Maximum 25 mT at distance of 4 mm from the drive).

IMPORTANT

Do not place a device sensitive to a magnetic field near the optical disk drive.

(6) External light source

Mount the optical disk drive away from strong light sources (e.g., camera flash).

(7) System ground

The optical disk drive should be grounded to the signal ground (SG) of the power supply of the system. This SG line should be supplied with the system.

The Frame Ground is shorted in the optical disk drive by a metal strip attached to the vibration isolation rubber between the frame (FG) and the base (SG).

IMPORTANT

When mounting the optical disk drive in the Device Bay 120mm (5 inch) of the PC chassis, there are two ways of choosing frames the metal frame and the plastic (nonconductive material) frame.

When using a plastic frame, there is not a short circuit between FG of PC and FG of the optical disk drive. As a result, the static electricity tolerance decreases compared with metal frame.

It is recommended to use a metal frame to enhance the static electricity prevention.

3.3 Power Supply Requirements

(1) Allowable input voltage and current

The DC power supply input voltage measured at the power supply connector pin of the optical disk drive (receiving end) must satisfy the requirements in Section 2.1.3.

(2) Current waveform (reference)

Figure 3.8 shows the +5 VDC waveform at seek.

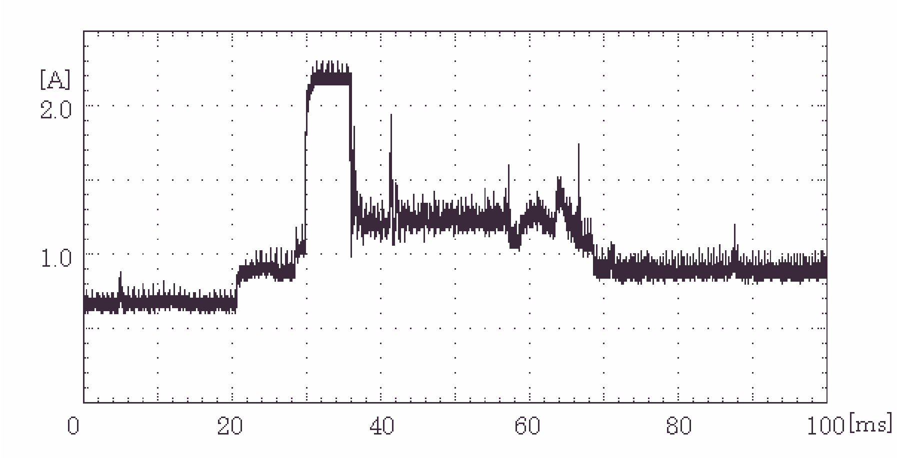


Figure 3.8 Current waveform (+5 VDC)

3.4 Cable Connections

3.4.1 Drive connectors

The optical disk drive (ODD) has connectors. Figure 3.9 shows the location of the connectors.

- AT interface connector (40-pin) and power supply connector (4-pin)

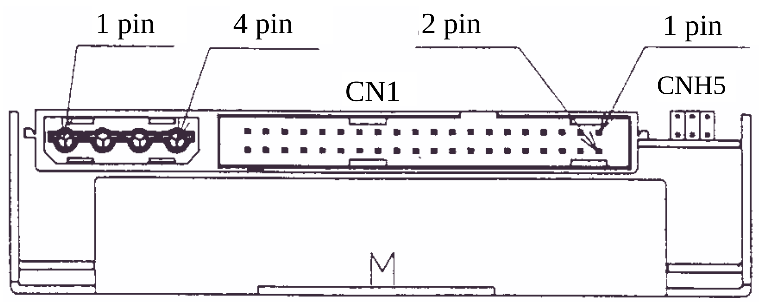


Figure 3.9 Connector and terminal locations

Power supply connector

1	+12 VDC or not connected
2	+12 VDC RETURN (GND) or not connected
3	+5 VDC RETURN (GND)
4	+5 VDC

3.4.2 Cable connector specifications

Table 3.3 lists the recommended cable connector specifications.

Table 3.3 Cable connector specifications

Cable name	Name	Model name	Vendor
AT interface cable (40-pin)	Cable socket (Close end type)	FCN-707B040-AU/B	Fujitsu
	Cable socket (Through-end type)	FCN-707B040-AU/0	Fujitsu
	Signal cable	445-248-40	SPECTRS STRIP
Power cable	Cable socket housing	1-480424-0	AMP
	Contact	170121-4	AMP
	Signal cable	AWG18	

IMPORTANT

The host interface cable must be a flat cable in terms of its overall length. (Do not use a cable with a flat crimp terminal and loose lines or twisted pairs.)

3.4.3 Drive connection

Figure 3.10 is a diagram showing cable connections between equipment.

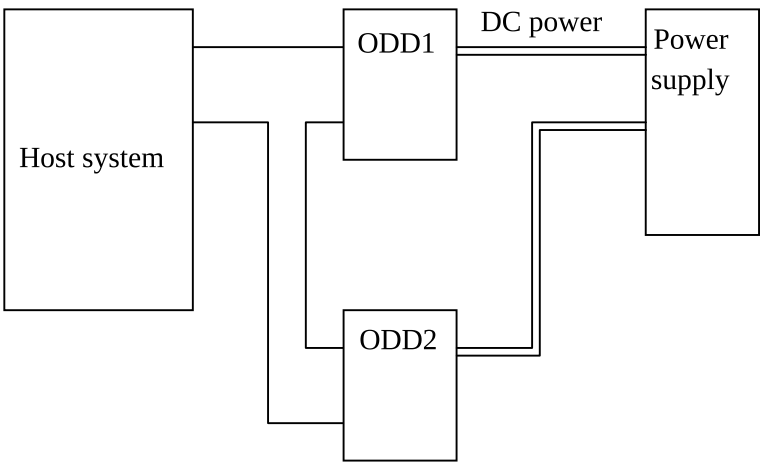
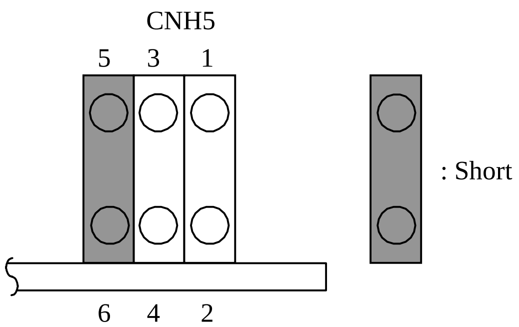


Figure 3.10 Cable connection diagram

3.5 Jumper Settings

3.5.1 Jumper settings at factory shipping

Figure 3.11 shows jumper settings at factory shipping.



5-6 short-circuited: Sets the master device.

Figure 3.11 Jumper settings at factory shipping

3.5.2 Mode setting

(1) Setting master device mode

Figure 3.12 shows the setting for recognizing the master device (device 0).

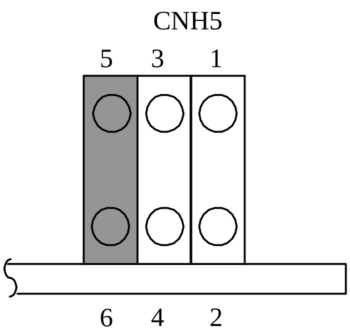


Figure 3.12 Master device setting

(2) Setting slave device mode

Figure 3.13 shows the setting for recognizing the slave device (device 1).

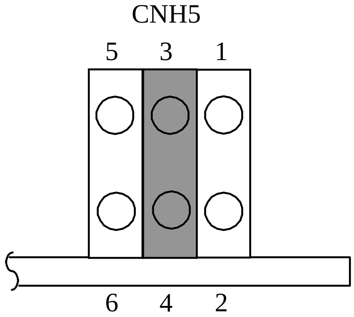


Figure 3.13 Slave device setting

(3) Setting cable select mode

Figure 3.14 shows the master device/slave device setting when the CSEL signal is connected to the interface. In the example shown in Figure 3.15, this setting requires a special interface connection.

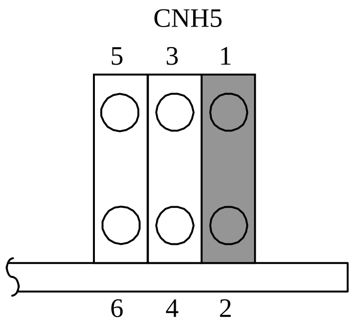


Figure 3.14 Cable select mode setting

Figure 3.15 shows a cable select example using a special interface cable.

This example connects CSEL of the master device to the CSEL line (conductor) of the cable, then grounds it so that the drive recognizes that it is the master. At this time, the CSEL conductor of the slave device is removed and cannot be connected to CSEL of the cable, so that the drive recognizes that it is the slave.

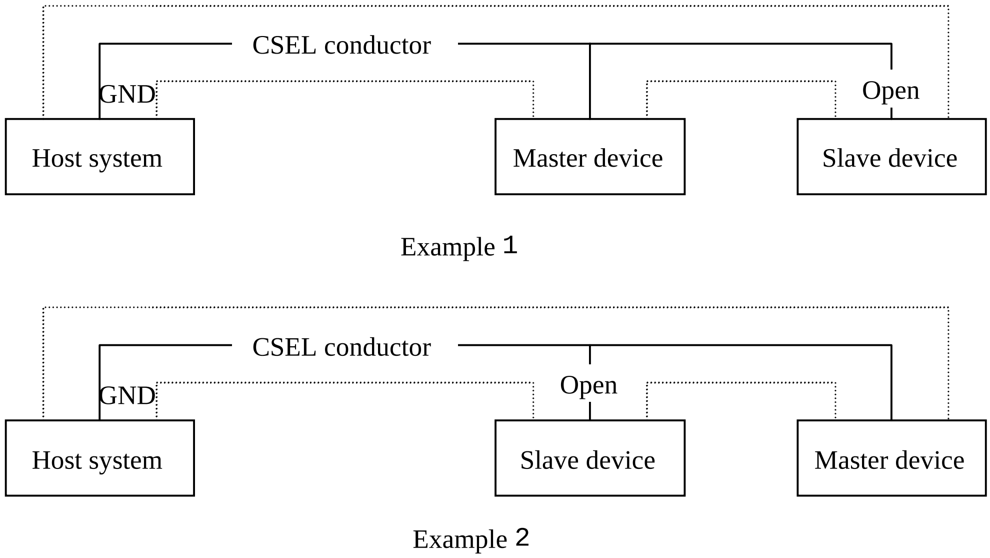


Figure 3.15 Cable select examples

3.6 Notes on Drive Handling

(1) General notes

Note the following points to maintain drive performance and reliability:

CAUTION

Device damage:

1) Shock or vibration applied to the drive that exceeds the values defined in the standard damage the drive. Use care when unpacking.
2) Do not leave the drive in dirty or contaminated environments.
3) Since static discharge may destroy the CMOS devices in the drive, pay attention to the following points after unpacking:
   - Use an antistatic mat and wrist strap when handling the drive.
   - Hold the mounting frame when handling the drive. Do not touch the Printed circuit board except when setting the switches.
4) When handling the drive, hold both sides of the mounting frame. When touching other than both sides of the mounting frame, avoid putting force.
5) Do not forcibly push up the end of the header pin of the printed circuit board unit when handling or setting the drive.

(2) Unpacking

a) Make sure that the UP label on the package is pointing upward and start unpacking on a level surface. Handle the drive on a soft surface such as a rubber mat, not on a hard surface such as a desk.

b) Use care to avoid exerting excessive pressure on the unit when removing the cushions.

c) Use care to avoid exerting excessive pressure on the printed circuit board surface and interface connectors when removing the drive from the antistatic bag.

d) If the temperature difference between installation locations is 10 degrees or more, leave the drive in the new location for at least two hours before unpackaging it.

(3) Installation

a) Do not connect or disconnect the connectors or change the terminal settings when the power is on.

b) Do not move the drive with the power on.

c) Eject the optical disk cartridge, lock the carriage securing the head, turn off the power, then move the drive.

⚠CAUTION

Device damage: Be sure to turn on the power supply before inserting your cartridge for the first time. It releases the device from transport protection and enables you to insert the cartridge.

The device may be damaged if you insert the cartridge without releasing the protection. From the next time, you don't need to turn on the power supply beforehand.

Before moving the drive, remove the optical disk cartridge. If the drive is moved with the optical disk cartridge loaded in it, the head may move back and forth in the drive to damage the head or disk and reading the data may fail.

(4) Packing

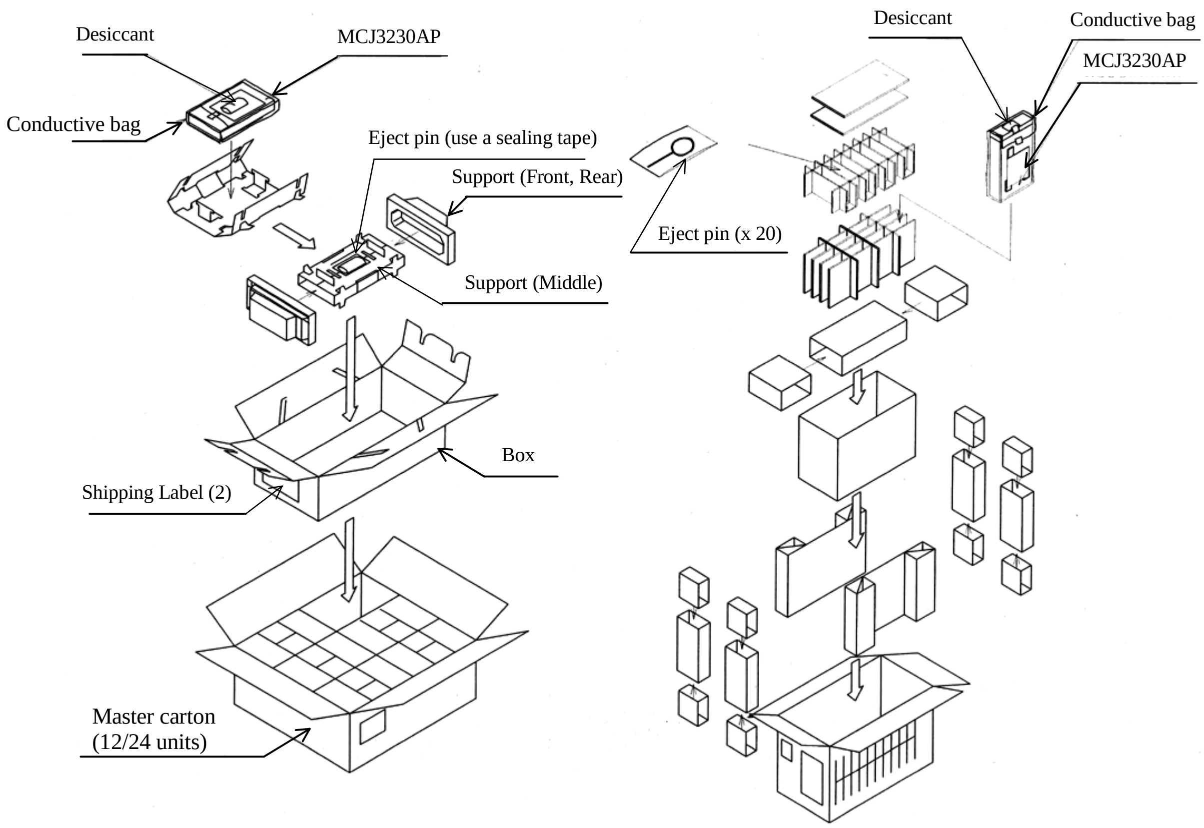
a) Before packing, remove the optical cartridge.

b) Store the drive in an antistatic plastic bag with desiccant (silica gel).

c) Use the same cushions and packaging supplied with the drive. If they are not available, ensure that adequate shock absorbent material is used. In this case, some method of protecting the printed circuit board surface and interface connectors must be used.

d) Apply "UP" and "Handle With Care" labels to the outside of the package.

Figure 3.16 shows the single-unit packing style and the multiple-unit packing style. (The form and material of the cushion may be changed.)



Single-unit packing　　　　Multiple-unit packing

Figure 3.16 Packing style

(5) Transportation

a) Transport the optical disk drive packed in principle, with the UP sign upward.

b) After unpacking, minimize the transportation distance and use cushions to avoid shock and vibration. Transport the drive in one of the orientations described in Subsection 3.2.2 after unpacking. (The horizontal direction is recommended.)

(6) Storage

a) Use moistureproof packaging when storing the drive.

b) The storage environment must satisfy the requirements specified in Subsection 2.1.3 when the drive is not operating.

c) To prevent condensation, avoid sharp changes in temperature.

3.7 Mounting

3.7.1 Checks before mounting the drive

Before mounting the optical disk drive in the system cabinet, check whether the jumper settings are set correctly.

3.7.2 Mounting procedure

How the drive is mounted depends on the system cabinet structure. Determine the mounting procedure in consideration of the requirements of each system. This section contains the general mounting procedure and check items.

See Section 3.2 for details on mounting drive.

1) Tighten four mounting screws to secure the drive in the system cabinet.

   – The drive has ten mounting holes (both sides: 3 × 2, bottom: 4). Secure the drive using the four mounting holes on both sides or the bottom.

   – Use mounting screws whose lengths are 3 mm or less from the external wall of the mounting frame of the drive when they are tightened. (See Figure 3.6)

   – When mounting with screws, the screw tightening torque should be 0.4 to 0.45Nm (4 to 4.6kgfcm).

   – Be careful not to damage the parts on the PCA when mounting the drive.

2) After securing the drive, make sure that the drive does not touch the chassis of the system cabinet. There must be at least 1.5 mm clearance between the drive and chassis. (See Figure 3.6)

3.8 Cable Connections

Use the following cables to connect the drive to the system. See Subsection 3.4 for details on the connector positions and cable requirements.

- Power supply cable
- AT interface cable
- DC ground cable (if required)

The general procedure for cable connection and notes on connecting cables are given below. Pay attention to the insertion direction of each cable connector.

⚠CAUTION

1) Make sure that the system power is off.
2) Do not connect or disconnect any cable when the power is on.

1) Connect the DC ground cable (only if required to decrease ground noise).
2) Connect the power cables.
3) Connect the AT interface cable.
4) After each cable connector is connected, secure the cable so that the cable does not touch the drive or the parts on the PCA or obstruct the flow of cooling air in the system cabinet.

3.9 Operation Confirmation and Preparation for Use after Installation

3.9.1 Confirming initial operations

This section provides the operation check procedures after the power is turned on.

(1) Initial operation when the power is turned on

- When the power is turned on, the drive starts initial self-diagnosis. The LED on the front panel is on for 1 second during initial self-diagnosis.
- If an error is detected during initial self-diagnosis, the LED on the front panel blinks.
- In case of not inserted the cartridge, when the power is turned on, the eject motor automatically turns once.

(2) Checks if errors occur at initial self-diagnosis

- Make sure that the cables are connected correctly.
- Make sure that the supply voltage is correct. (Measure the voltage at the power supply connector of the optical drive.)
- Make sure that the settings of all terminals are correct.
- If the LED on the front panel blinks continuously, an error was detected during initial self-diagnosis. In this case, issue the REQUEST SENSE command from the initiator (host system) to obtain sense data for error analysis.

⚠CAUTION

The BUSY LED is on while the optical disk drive is executing seek, write, or read operations. The BUSY LED is on momentarily, so it seems as if it blinked or is off.

The eject motor turns once when the power is turned on so that in case the spindle motor position deviates due to shocks received by the drive during transport the position is corrected to allow the cartridge to be inserted normally. If the cartridge fails to be inserted, remove the cartridge and turn on the drive power to turn the eject motor once and reinsert the cartridge.

3.9.2 Connection check

When initial operation check terminates normally after the power is turned on, check whether the drive is correctly connected by issuing command from the host system. Checking procedure depends on the host system configuration.

If processing terminates abnormally:

a) If sense data has been obtained by the REQUEST SENSE command, analyze the sense data. If the error is recoverable, retry the processing.

b) Check the following items for AT interface cable connection:

   – All connectors, including other devices, are connected correctly.

   – Make sure the correct cable is being used (whether it corresponds with the cable selection mode).

c) Make sure again that the jumper settings are correct.

3.10 Dismounting Drive

How to demount an optical disk drive (for setting terminal checking, setting change, or device replacement) depends on the system cabinet configuration. Determine the demounting procedure in consideration of the requirements of each system. This section describes the general demounting procedure and notes on demounting drives.

⚠CAUTION

Device damage: Before demounting the optical disk drive, turn off the system power. Do not remove screws securing the cables and drive when the power is on.

1) Remove the power cable.
2) Remove the AT interface cable.
3) Remove the DC ground cable.

4) Remove the four screws securing the drive, then remove the drive from the system cabinet.

5) When storing or transporting the drive, put the drive into an antistatic bag. (See Section 3.6.)

CHAPTER 4 Host Interface

This chapter describes host interface specification.

4.1 Pin Assignment

The table below lists pin assignments of the interface connector.

Table 4.1 Connector pin assignments (1/2)

Description	PIN	Signal name
Reset	1	RESET-
Ground	2	Ground
Data bus bit 7	3	DD7
Data bus bit 8	4	DD8
Data bus bit 6	5	DD6
Data bus bit 9	6	DD9
Data bus bit 5	7	DD5
Data bus bit 10	8	DD10
Data bus bit 4	9	DD4
Data bus bit 11	10	DD11
Data bus bit 3	11	DD3
Data bus bit 12	12	DD12
Data bus bit 2	13	DD2
Data bus bit 13	14	DD13
Data bus bit 1	15	DD1
Data bus bit 14	16	DD14
Data bus bit 0	17	DD0
Data bus bit 15	18	DD15
Ground	19	Ground
(keypin)	20	Reserved
DMA Request	21	DMARQ
Ground	22	Ground
I/O Write Stop during Ultra DMA data bursts	23	DIOW- STOP
Ground	24	Ground
I/O Read DMA ready during Ultra DMA data in bursts Data strobe during Ultra DMA data out bursts	25	DIOR- HDMARDY- HSTROBE

Table 4.1 Connector pin assignments (2/2)

Ground	26	Ground
I/O Ready DMA ready during Ultra DMA data out bursts Data strobe during Ultra DMA data in bursts	27	IORDY DDMARDY- DSTROBE
Cable Select	28	CSEL
DMA Acknowledge	29	DMACK-
Ground	30	Ground
Interrupt Request	31	INTRQ
16 Bit I/O	32	IOCS16-
Device Address Bit 1	33	DA1
PASSED DIAGNOSTICS Cable assembly type identifier	34	PDIAG- CBLID-
Device Address Bit 0	35	DA0
Device Address Bit 2	36	DA2
Chip Select 0	37	CS0-
Chip Select 1	38	CS1-
Device Active or Slave (Device 1) Present	39	DASP-
Ground	40	Ground

4.2 Signal Description

Table 4.2 Signal description (1/2)

PIN	Signal name	I/O	Description
1	RESET-	I	Reset signal
3, 5, 7, 9, 11, 13, 15, 17, 18, 16, 14, 12, 10, 8, 6, 4	DD7-0 DD15-8	I/O	The low-order bus is a 8-bit bidirectional bus signal for exchanging the status, data, and control data between the host and ODD. The high-order bus is used for 16-bit data transfers only.
21	DMARQ	O	Data request signal for DMA transfer
23	DIOW- STOP	I	Write strobe signal. Indicates that transfer has ended at Ultra DMA transfer.
25	DIOR- HDMARDY- HSTROBE	I	Read strobe signal Indicates that the host can receive Ultra DMA data at Ultra DMA in transfer. The ODD latches data at both edges of this signal at Ultra data out transfer.
27	IORDY DDMARDY- DSTROBE	O	This is the ready signal for the host computer. The ODD uses this signal to request an extension of the transfer cycle when it cannot prepare a response to a data transfer request from the host computer in time. Indicates that the ODD can receive Ultra DMA data at Ultra DMA out transfer. The host latches data at both edges of this signal at Ultra data in transfer.
28	CSEL	I	Sets the ODD to the master (device 0) or slave (device 1). Effective by jumpering.
29	DMACK-	I	Answer signal in response to DMARQ during DMA transfer
31	INTRQ	O	Interrupt signal to the host
32	IOCS16-	O	Indicates that the ODD is ready for 16-bit transfer when the host addresses the 16-bit data port during PIO transfer.
36, 33, 35	DA2, 1, 0	O	Address signal used by the host to address the ODD task file register
34	PDIAG- CBLID-	I/O	Used by the slave (device 1) to notify the master (device 0) that diagnostics ended

Table 4.2 Signal description (2/2)

PIN	Signal name	I/O	Description
37	CS0-	O	Select signal used to select the command block register
38	CS1-	O	Select signal used to select the control block register
39	DASP-	I/O	When reset, slave (device 1) output signal indicating that the slave (device 1) exists. Otherwise, the signal indicates that the master (device 0) and slave (device 1) is performing mechanical operation or a failure occurred.
2, 19, 22, 24, 26, 30, 40	Ground	-	Ground signal

4.3 Interface Registers

4.3.1 I/O registers

This section provides the I/O register functions and mapping. Definitions of each register vary depending on which ATA or ATAPI commands are used.

Table 4.3 I/O port functions and mapping

Address signal					Function	
CS0-	CS1-	DA2	DA1	DA0	READ (DIOR-)	WRITE (DIOW-)
N	N	x	x	x	High impedance state	Ineffective
					Control block register	
N	A	0	x	x	High impedance state	Ineffective
N	A	1	0	x	High impedance state	Ineffective
N	A	1	1	0	Alternate Status	Device Control
N	A	1	1	1	Drive Address	Ineffective
					Command block register	
A	N	0	0	0	Data	
A	N	0	0	1	Error	ATA Features (ATA) ATAPI Features (ATAPI)
A	N	0	1	0	Sector Count (ATA)	
					ATAPI Interrupt Reason (ATAPI)	Ineffective
A	N	0	1	1	Sector Number	
A	N	1	0	0	Cylinder Low (ATA) ATAPI Byte Count (bits 0-7) (ATAPI)	
A	N	1	0	1	Cylinder High (ATA) ATAPI Byte Count (bits8-15) (ATAPI)	
A	N	1	1	0	Device/Head (ATA) ATAPI Block Device Select (ATAPI)	
A	N	1	1	1	ATAPI Status	ATA Command
A	A	x	x	x	Ineffective	Ineffective

The letter A indicates that the bit is asserted, N indicates that the bit is negated, and X indicates that the bit is ignored.

4.3.1.1 Alternate Status register

This register contains the same information as that of the ATAPI Status register, except that the ODD does not recognize interrupts when reading this register. Therefore, the ODD does not clear the INTRQ signal and does not clear interrupts during the pending.
For details of each bit, see Section 4.3.1.14.

Table 4.4 Bit definitions of Alternate Status register

7	6	5	4	3	2	1	0	
BSY	DRDY	Reserved	SERV	DRQ	Reserved	Reserved	CHK	Read

4.3.1.2 ATA Command register

This register contains a command to be passed to the ODD. The ODD starts executing a command immediately after the command is written in this register. For executable commands and required parameters, see Table 4.38.

4.3.1.3 Data register

The data register is used for data transfer. The data width is always 16 bits.

4.3.1.4 Device Control register

This register's bits are defined as shown below.

Table 4.5 Bit definitions of Device Control register

7	6	5	4	3	2	1	0	
Reserved	Reserved	Reserved	Reserved	Reserved	SRST	nIEN	0	Write

- Bits 7 to 3 are reserved. The ODD ignores all value sets in these bits.
- 0 should be set for bit 0. The ODD ignores the value set in this bit.
- SRST is a reset bit for host software.
- nIEN is an enable bit for device interrupts to the host. When nIEN is 0 and the device is selected, the INTRQ signal is enabled by the tri-state buffer. When nIEN is 1 or the device is not selected, the INTRQ signal is in the high-impedance state.

4.3.1.5 Drive Address register

This register's bits are defined as shown below.

Table 4.6 Bit definitions of Drive Address register

7	6	5	4	3	2	1	0	
HiZ	nWTG	nHS3	nHS2	NhS1	nHS0	nDS1	nDS0	Read

- HiZ is always in the high-impedance state.
- nWTG indicates the status of the ODD internal data write control signal (Write Gate).
- nHS3 indicates a binary complement of bits 3 to 0 of the drive select register.
- nDS1 is the device select bit for device 1. It is 0 when device 1 is selected.
- nDS0 is the device select bit for device 0. It is 0 when device 0 is selected.

4.3.1.6 ATAPI Byte Count register

This register's bits are defined as shown below.

Table 4.7 Bit definitions of ATAPI Byte Count register

7	6	5	4	3	2	1	0	
Byte Count (Bits 7-0)								R/W
Byte Count (Bits 15-8)								R/W

- This register is used for PIO transfer only. The ODD sets the byte count to be transferred by the host in this register and sets DRQ to 1. The ODD does not update this register until transfer starts.

4.3.1.7 ATAPI Block Device Select register

This register's bits are defined as shown below.

Table 4.8 Bit definitions of ATAPI Block Device Select register

7	6	5	4	3	2	1	0	
Unused	Unused	Unused	Dev	Unused	Unused			R/W

- Bits 7, 6, 5, 3, 2, 1, and 0 are not used. The ODD ignores all value sets in these bits.
- Dev indicates the device address. When Dev is 0, device 0 is selected and when Dev is 1, device 1 is selected.

4.3.1.8 Error register

This register indicates the status of the final command.

The value of this register is effective when the ERR bit of the Status register is 1 at completion of a command other than EXECUTE DEVICE DIAGNOSTIC.

The value of this register indicates the diagnostic code at power-on, reset, and execution of the EXECUTE DEVICE DIAGNOSTIC command. For details on diagnostic codes, see Section 4.5.3.

Table 4.9 Bit definitions of Error register

7	6	5	4	3	2	1	0	
Sense Key				MCR	ABRT	EOM	ILI	Read

- For the Sense Key, see Table 4.102.
- MCR (Media Change Requested) is not used. It is always 0.
- ABRT (Aborted Command) indicates that the value of the ATA command code or task file register is incorrect.
- EOM (End of Media) is not used. It is always 0.
- ILI (Illegal Length Indication) is not used. It is always 0.

4.3.1.9 ATA Features register

This register is used for the SET FEATURES command.

4.3.1.10 ATAPI Features register

This register's bits are defined as shown below.

Table 4.10 Bit definitions of ATAPI Features register

7	6	5	4	3	2	1	0	
Reserved						OVERLAP	DMA	Write

- All values in bits 7 to 2 are ignored.
- OVERLAP is not used. The ODD ignores the value set in this bit.
- When DMA is 1, the ODD performs DMA transfer for data transfer.

4.3.1.11 ATA Sector Count register

This register is used for the SET FEATURES command.

4.3.1.12 ATAPI Interrupt Reason register

This register's bits are defined as shown below.

Table 4.11 Bit definitions of ATAPI Interrupt Reason register

7	6	5	4	3	2	1	0	
Reserved	Reserved	Reserved	Reserved	Reserved	REL	I/O	C/D	Read

- Bit 7 to 3 are reserved. It is always 0.
- REL is not used. It is always 0.
- I/O indicates the direction of data transfer. See Table 4.12.
- I/O indicates the type of transfer. See Table 4.12.

Table 4.12 I/O and C/D

I/O	C/D	Meaning
0	1	Packet command transfer
1	0	Data or parameter transfer (from the ODD to the host)
0	0	Data or parameter transfer (from the host to the ODD)
1	1	The completion status in the Status register is effective.

4.3.1.13 Sector Number register

This register is not used. The ODD ignores all specified values.

4.3.1.14 ATAPI Status register

This register indicates the status of the ODD. It is updated to reflect the current ODD status and the progress of the current command. When the BSY bit is 0, other bits of the register are effective and some other command block registers may be set with significant information. When the BSY bit is 1, the other bits of this register and all other command block registers are ineffective.

While the ODD is in sleep mode, the ATAPI Status register and all other command block registers are ineffective.

If the host reads this register during interrupt pending, the interrupt is cleared.

Table 4.13 Bit definitions of ATAPI Status register

7	6	5	4	3	2	1	0	
BSY	DRDY	Reserved	SERV	DRQ	Reserved	Reserved	CHK	Read

- Bit 5, 2, and 1 are reserved. They are always 0.
- BSY (Busy) is set during command block register control. When BSY is 1, the ODD ignores all command block registers other than the Device Reset command.

The ODD updates the DRQ and CHECK values only when BSY is 1. After the final block of the PIO data-in command is transferred, the BSY bit setting is canceled and the DRQ bit is cleared.

When BSY is 0, the ODD may update the SERVICE bit of the ATAPI Status register and the Data register. The ODD does not update all other command block registers and the ATAPI Status register bits.

The ODD sets BSY:

a) After RESET- is negated or within 400 ns of setting the SRST bit of the Device Control Register

b) Within 400 ns of receiving a command when the DRQ bit is not set

c) Between data transfer blocks of the PIO data-in/PIO data-out command when the DRQ bit is not set

d) After data block transfer with the PIO data-out command when the DRQ bit is not set

e) During DMA transfer when the DRQ bit is not set

In all other cases, the ODD does not set BSY.

If BSY is set after RESET- is negated, the SRST bit is set, or a Device Reset command is issued, it remains set until the ODD completes the internal reset process.

- DRDY (Device Ready) is always 1, except at the time after reset is made until the next command is issued.
- For SERV, set the same value as that of DRDY. The SERV bit should be ignored from the standpoint of compatibility.
- DRQ (Data Request) indicates that the ODD can transfer one byte or one word to or from the host. When DRQ is 1, the ATAPI Interrupt Reason register of the current packet command is effective.
- CHK indicates that an error occurred in command processing. The Error register contains additional information on the cause of the error. When the ODD sets CHK to 1, the items below are not changed until a new command is received or the ODD is reset.
    - CHK bit of the Status register
    - Error register
    - Device/Head register

4.4 Various Processes

4.4.1 Reset response

There are four types of resets.

- Power-on reset
  - The ODD performs initialization such as initial diagnostics and default setting. If any media is mounted, it also spins up media.
- Hardware reset
  - The ODD is reset when the RESET- signal is asserted. The ODD initializes the interface controller by setting default values.
  - UNIT ATTENTION is generated.
- ATA software reset
  - The ODD is reset when the SRST bit of the Device Control register is set.
  - The device driver should not use the SRST bit to reset the ODD (except for restore from sleep mode).
  - After ATA software reset, the ODD initializes the task file as shown below.

    Status = 00h

    Error = (Depending on the SRST sequence)

    Sector Count = 01h

    Sector number = 01h

    Cylinder Low = 14h

    Cylinder High = EBh

    Drive/Head = 00h
  - DRDY is set to 1 with the first command after ATA reset.
  - If ATA software reset is issued while the ODD is selected and a command is being executed (BSY = 1 or DRQ = 1), the command is interrupted. Otherwise, the ODD continues command processing.
  - The contents set with the MODE SELECT and Set Features commands remain unchanged.
- ATAPI reset
  - The ODD is reset with a DEVICE RESET command. The ODD interrupts the current command.

– UNIT ATTENTION is not generated.

– The contents set with the MODE SELECT and Set Feature commands remain unchanged.

4.4.2 Signature

The ODD specifies the following as signatures that indicate the support of the PACKET command function in the task file.

Sector Count = 01h

Sector Number = 01h

Cylinder Low = 14h

Cylinder High = EBh

Drive/Head = 00h or 10h

The ODD sets signatures in the task file when any of the following occurs.

- Power on reset
- Hardware reset
- Software reset
- Reception of Device Reset command
- Reception of Execute Device Diagnostic command
- Reception of Identify Device command (command code ECh)
- Reception of Read Sector(s) command (command code 20h)

When the Device Reset command, the Identify Device command, or the Read Sector(s) command is received, the DEV bit is not changed.

4.4.3 Defect sector management

Sector mapping is executed based on the ISO/IEC 10090 standard for 128 MB media, the ISO/IEC 13963 standard for 230 MB media, the ISO/IEC 15041 standard for 540 and 640 MB media, and Cherry Book for 1.3 GB media, the Cherry Book 2 for 2.3GB media. Basically, possibly defective sector management is not required for the host.

Defective sectors cannot be deleted from the host, except for certifying recordable areas. Recordable areas can be certified with the FORMAT UNIT command.

4.4.4 Automatic alternate sector assignment function

The ODD automatically assigns an alternate sector if a verify error is detected in the ID or data section during the WRITE (I0) command, or WRITE AND VERIFY and ERASE command. Alternate sector information is registered in SDL (Secondary Defect List) on media.

After automatic alternate assignment terminates successfully, the ODD does not report any error.

4.4.5 Cache function

The ODD supports the read cache and MO write cache.

The read cache consists of the read ahead cache and the LRU cache that reads write data remaining in the data buffer.

The read ahead cache allows for data transfer at a near effective transfer speed during continuous read operation without causing any delay owing to rotation latency. LRU allows for data transfer with no mechanical operation if write and read operations are executed frequently on the same sector.

The MO write cache writes data in batch mode during continuous write operation, thus reducing positioning operations depending on the buffer size and recovering the write throughput.

4.4.5.1 Data buffer

The ODD uses part of the buffer area as work memory for control firmware and the remaining area as a buffer. The data buffer consists of plural segments and contains write data of plural segments.

4.4.5.2 Read cache

The ODD enables the read ahead cache and LRU cache when the cache function is enabled. When the read cache is enabled, the ODD contiguously pre-reads the specified sector, then pre-reading the next sector when receiving a READ command (called Read command in this document). While pre-reading the next sector, the ODD transfers the data in the sector specified by the command.

When data in the sector specified by the host hits pre-read data, the ODD transfers data directly from the buffer without any mechanical operation.

Pre-read stops under the following conditions:

- Read error
- When the data buffer is full (Pre-read may start again when the buffer becomes sufficient.)
- Media ejection instruction using the Eject switch
- Power-off
- When It is decided that the performance becomes better by stopping pre-reading and give priority to other processings.

When the cache is enabled, the buffer contains data transferred from the host with a write command. If a read command is issued to the sector address at this time, the ODD directly transfers data to the high-level equipment from the data buffer

without reading it from media. If the cache is hit with a read command, the ODD makes the data in the hit segment being kept in the highest priority.

The data listed below cannot be stored in the read cache.

- Data read before power-off
- Data already stored before media is mounted

All buffer data is discarded under the following conditions:

- Power-off
- When media is ejected
- When the FORMAT UNIT command is received
- In standby mode
- In sleep mode

Buffer data my be discarded under the following condition:

- When the system receives the MODE SELECT and SET FEATURES command that may change the reading mode

4.4.5.3 MO write cache

When the write cache is enabled, the ODD responds to the host with command end. This occurs when the data transfer is done with the WRITE command or WRITE AND VERIFY command (hereafter "Write command" in this document).

The ODD writes data kept in the buffer to media under the following conditions:

- When the Eject switch is pressed
- When the SYNCHRONIZE CACHE command is received
- When the FLUSH CACHE command is received

Under the conditions given below, write data in the buffer may not be written properly on media:

- Power-off
- Forced media ejection (mechanical ejection)

4.4.6 Media status notification function

The media status notification function notifies the host of various information on the removable media device. The function is enabled or disabled with the SET FEATURES command.

When the media status notification function is enabled, the functions below will be added or changed.

- The GET MEDIA STATUS command is enabled.
- The Eject switch is disabled.

The media status notification function is disabled at power-on reset, software reset, when the DEVICE RESET command is received, or when the EXECUTE DEVICE DIAGNOSTIC command is received.

4.4.7 Power management function

The ODD provides the power management function that minimizes the power consumed. For this function, the ODD has some control commands and a timer. The host uses the functions below to control the power management function.

1) Standby timer
2) Idle Immediate command
3) Sleep command
4) Standby Immediate command

4.4.7.1 Power mode

The ODD supports power modes shown below. The ODD uses a power mode equivalent to standby mode, except that the DRDY bit is 0 while media is not mounted.

- Active mode
- Pre-idle mode
- Idle mode
- Standby mode
- Sleep mode

4.4.7.2 Active mode

In active mode, all circuits are enabled. The ODD requires the shortest time to start processing a command.

4.4.7.3 Pre-idle mode

In pre-idle mode, the read/write circuits stop. The ODD can receive a command from the host, but since some circuits stop, the command requires 20 ms to access media.

The ODD automatically enters pre-idle mode if no command is issued within a specified time (0.5 second) in active mode. When it receives an access command, the ODD automatically enters active mode. The pre-idle mode cannot be controlled from the host computer.

4.4.7.4 Idle mode

In idle mode, the servo and read/write circuits stop. The ODD can receive a command from the host, but because some circuits stop, the ODD takes 1 s seconds (standard) to access media.

If no command is issued within a specified time (180 s) in active mode, the ODD automatically enters pre-idle mode, then enters idle mode. When it receives an access command, the ODD automatically returns active mode. The Idle Immediate command can shift the ODD from active mode or standby mode to idle mode.

4.4.7.5 Standby mode

In standby mode, the spindle motor stops. The ODD can receive a command from the host, but since the spindle motor stops, the recovery to access media takes 5 s (standard).

The ODD automatically enters standby mode from active mode if no command is issued within a specified time when the standby timer is enabled. When it receives a command, the ODD automatically returns active mode. The Standby Immediate command can also directly shift the ODD from active or idle mode to standby mode.

4.4.7.6 Sleep mode

Sleep mode uses power consumption as standby mode. To set the ODD in sleep mode, the host must issue the Sleep command. To restore the ODD from sleep mode, hardware reset or software reset is required. The host must not issue any command after the Sleep command. The ODD requires 15 s (standard) to respond.

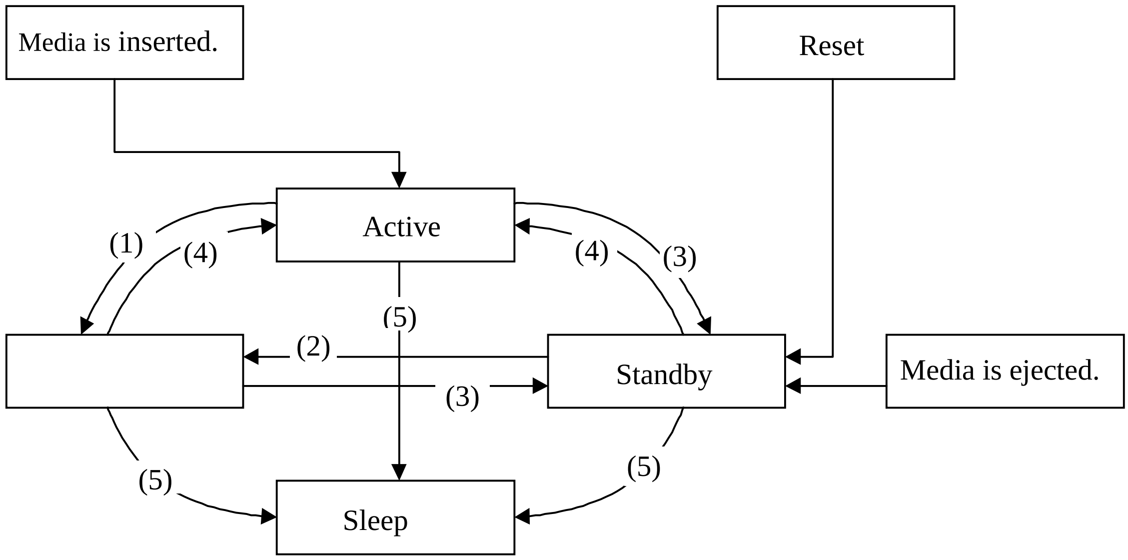
4.4.7.7 Standby timer

The standby timer is used to count the time during which the host issues no command.

The standby timer value is programmable with the Power Condition Page of the MODE SELECT command. The default value is 32 minutes (including the transition time to idle mode).

4.4.7.8 Power mode transition

The power mode transits as shown in Figure 4.1.



(1) The ODD enters idle mode because it receives the Idle Immediate command or because it receives no commands within a specified time.

(2) The ODD enters idle mode with the Idle Immediate command.

(3) The ODD enters standby mode with the Standby Immediate command and standby timer.

(4) The ODD enters active mode because it receives a media access command.

(5) The ODD enters sleep mode with the Sleep command.

Figure 4.1 Power mode

4.4.8 Unsupported functions

The ODD does not support the following functions which are covered by the ATA/ATAPI-5 standard.

- Overlapped feature set
- Queued feature set
- Advance Power Management feature set
- Security Mode feature set
- Power-Up In Standby feature set

The ODD also does not support the following functions which are not supported by ATAPI devices.

- SMART feature set
- Host Protected Area feature set

4.4.9 LED Indications

The ODD notifies the operator of a serious error by turning on or blinking the LED lamp. Table 4.16 lists indication modes and operation.

Table 4.16 LED indications

LED blink cycle	Operation
Off	Command wait state
On	Command processing
	Seek operation
	Read/write processing (including cache processing)
	Formatting
	Power-on diagnostics
	Spinning up (Including return from standby mode)
	Spinning down (Including shifting to standby mode)
Blinking (on for 0.1 second and off for 0.7 seconds repeatedly)	Starting the download only firmware (*1)
Blinking (on for 0.1 second and off for 0.1 second repeatedly)	A power-on diagnostics error occurred.
Blinking (on for 0.4 seconds and off for 0.4 seconds repeatedly)	A thermal alarm occurred.
Blinking (on for 0.1 second and off for 0.3 seconds repeatedly)	An error occurred during writing to the WRITE cache (*2)

*1 The ODD control firmware is stored on the flash ROM and can be downloaded from the host with the WRITE BUFFER command. However, if any problem occurs during downloading, such as power failure, downloading is interrupted and the microcodes in the control firmware may be damaged. To download microcode data again in such a case, the ODD starts the emergency download firmware that simply supports only the WRITE BUFFER command and other basic commands.

*2 The blinking of the LED for the error during writing to the WRITE cache is cancelled by ejecting the media.

4.5 ATA Commands

Table 4.17 lists supported ATA commands.

This section represents ODD registers as shown below.

Cylinders High/Low registers: CY

Sector register: SC

Device/Head register: DH

Sector Number register: SN

Features register: FR

Table 4.17 Command codes and parameters

Protocol	Command name	Command code	Parameters used					Section
			FR	SC	SN	CY	DH	
ND	CHECK POWER MODE	E5h		y			D	4.5.1
ND	DEVICE RESET	08h					D	4.5.2
ND	EXECUTE DEVICE DIAGNOSTIC	90h					D*	4.5.3
ND	FLUSH CACHE	E7h		y	y	y	D	4.5.4
ND	GET MEDIA STATUS	DAh					D	4.5.5
PI	IDENTIFY PACKET DEVICE	A1h					D	4.5.6
ND	IDLE IMMEDIATE	E1h					D	4.5.7
ND	NOP	00h					y	4.5.8
–	PACKET	A0h	y	y	y	y	D	4.5.9
ND	SET FEATURES	EFh	y	y			D	4.5.10
ND	SLEEP	E6h					D	4.5.11
ND	STANDBY IMMEDIATE	E0h					D	4.5.12
—	RESERVED: Other codes							

Notes:

1. y - This register contains parameters effective to run the command.

   D - Indicates that only the Device parameter is effective and the LUN parameter is ineffective.

   D* - Device 0 is addressed, but both devices execute the command.

2. The protocol above indicates the command protocol used.

ND - A non data command

PI - A PIO data-in command

4.5.1 CHECK POWER MODE (E5h)

Table 4.18 CHECK POWER MODE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	1	0	0	1	0	1
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The CHECK POWER MODE command sets the ODD power mode status in the SC register, then notifies the host of the value in Table 4.19 When the drive is in sleep mode, the interface is inactive and the ODD cannot receive this command.

Table 4.19 Power mode indication

Power mode status	SC register
Standby mode	00h
Entering standby mode	00h
Returning from standby mode	00h
Idle mode	80h
Pre-idle mode	FFh
Active mode	FFh

4.5.2 DEVICE RESET (08h)

Table 4.20 DEVICE RESET command

	Bit							
	7	6	5	4	3	2	1	0
CM	0	0	0	0	1	0	0	0
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The DEVICE RESET command resets the ODD.

When the ODD receives the DEVICE RESET command, it sets the BSY bit to 1. After reset is completed, the ODD sets the BUSY bit to 0. INTRQ is not asserted.

4.5.3 EXECUTE DEVICE DIAGNOSTIC (90h)

Table 4.21 EXECUTE DEVICE DIAGNOSTIC command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	0	1	0	0	0	0
DH	X	X	X	X	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

When the ODD receives this command, it recognizes self-diagnostics.

When the ODD receives this command, it responds to the command regardless of the DEV bit value; this means that the drive is unit 0 or 1.

When the ODD is device 0 (master), its response after the command is received depends on whether device 1 (slave) is connected.

When no device 1 is connected

The ODD sets 01h in the Error register and terminates the command.

When device 1 is connected

The ODD monitors the PDIAG- signal sent from device 1 for six seconds. If device 1 asserts the PDIAG- signal within this time, the ODD recognizes that the device 1 self-diagnostic test ends successfully. Otherwise, the ODD recognizes that the device 1 self-diagnostic test ended abnormally and the ODD makes OR-operation to its self-diagnostics results of unit 0 (Device 0) with 80h and sets it in the Error register. If device 1 ends abnormally, the ODD sets the CHECK bit of the Status register.

When the ODD is device 1

The ODD asserts the PDIAG- signal within five seconds. It sets 01h in the Error register and ends the command.

Table 4.22 Self-diagnosis detailed code

Detailed code	Meaning
01h	Normally end
02h-7Fh	Hardware error (For power-on and hardware reset only)
8xh	Device 1 ended abnormally. (For device 0 only)

4.5.4 FLUSH CACHE (E7h)

Table 4.23 FLUSH CACHE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	1	0	0	1	1	1
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The FLUSH CACHE command writes unwritten data in the cache memory in the data buffer to the media.

4.5.5 GET MEDIA STATUS (DAh)

Table 4.24 GET MEDIA STATUS command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	0	1	1	0	1	0
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The GET MEDIA STATUS command respond with the ODD status.

The command ends abnormally in either of the conditions given below and sets the value shown in Table 4.25 in the Error register.

- When no media is inserted
- When media is exchanged

- When the Eject switch is pressed
- When media is write-protected

Otherwise, the command ends normally. If a hardware error by which the command cannot be executed occurs, as is the case with other commands, the command ends with Aborted Command.

Table 4.25 Error register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	WP	MC	0	MCR	0	NM	0

WP: Set to 1 when write-protected.

MC: Set to 1 when media is exchanged. Reported only once.

MCR: Set to 1 when the Eject switch is pressed. Reported only once.

NM: Set to 1 when no media is inserted.

If this command is received while the media status notification function is disabled, this command responds with the ODD status assuming that the media status notification function is enabled. Subsequently, this command operates assuming that the media status notification function is enabled until it is set to disabled.

4.5.6 IDENTIFY PACKET DEVICE (A1h)

Table 4.26 IDENTIFY PACKET DEVICE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	1	0	0	0	0	1
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

When the ODD receives this command, it transfers device parameter information to the host. It accepts this command even if in standby mode.

Table 4.27 lists the transfer data format. The reserved word indicates a value of 0.

The transfer byte length is 512 bytes.

One-word information uses DD15 as MSB (Most Significant Bit) and DD0 as LSB (Least Significant Bit).

For ASCII character information such as base serial number, firmware version number, and product number, the first character code in the string uses word 1, DD15 to 8; the second character code uses word 1, DD7 to 0; the third character code uses word 2, DD15 to 8; and so on.

Table 4.27 Device parameter information (1/6)

Word	Value	Bits	Description
0	80C0h		General configuration information
		15-14	Protocol type (10b = ATAPI device)
		13	Reserved
		12-8	Device type 00000b = Direct access unit
		7	Replaceable media device 1b
		6-5	CMD DRQ type (10b = Accelerated DRQ)
		4-2	Reserved
		1-0	Command packet size (B'00' = 12 bytes)
1-9	0000h		Reserved
10-19	"xxx...xxx"		Base serial number (Left justified, ASCII codes)
20-22	0000h		Reserved
23-26	"aaab"		Firmware version number aaa: Major level version number (000 - 999) b: Minor level version number (0 - 9, a - z, and A - Z) (Left justified, ASCII codes, blank indicating space character)
27-46	“FUJITSU MCJ3230AP”		Product number (Left justified, ASCII codes, blank indicating space character)
47-48	0000h		Reserved
49	0F00h	15	Interleave DMA transfer supported (0b)
		14	Command queing supported (0b)
		13	Overlap function supported (0b)
		12	Reserved (0b)
		11	IORDY supported (1b)
		10	IORDY can be disabled (1b)
		9	LBA mode supported (1b)
		8	DMA transfer mode supported (1b)
		7-0	Unused (0b)

Table 4.27 Device parameter information (2/6)

Word	Value	Bits	Description
50	0000h		Reserved
51	0200h	15-8 7-0	PIO data transfer cycle timing mode Reserved
52	0000h	15-0	Reserved
53	0007h	15-3 2 1 0	Reserved Information in word 88 is valid. (1b) Information in words 64 to 70 is valid. (1b) Information in words 54 to 58 is valid. (1b)
54-62	0000h		Reserved
63	0407h (Default value)	15-11 10 9 8 7-3 2 1 0	Reserved (0b) Multiword DMA transfer mode 2 is selected. Multiword DMA transfer mode 1 is selected. Multiword DMA transfer mode 0 is selected. Reserved (0b) Multiword DMA transfer modes 2 to1 are supported.(1b) Multiword DMA transfer modes 1 and 0 are supported.(1b) Multiword DMA transfer modes 0 is supported.(1b)
64	0003h	15-2 1 0	Reserved (0b) PIO transfer modes 4 and under are supported.(1b) PIO transfer modes 3 and under are supported.(1b)
65	0078h (120)		Minimum multiword DMA transfer time per word (ns)
66	0078h (120)		Recommended multiword DMA transfer time (ns)
67	0078h (120)		Minimum PIO transfer cycle time when flow control is disabled (ns)
68	0078h (120)		Minimum PIO transfer cycle time when flow control using IORDY is enabled (ns)
69-70	0000h		Reserved
71	07D0h (2000)		Required time after the PACKET command is received until the bus is released (μs) (Typical)
72	0000h (0000)		Required time after the SERVICE command is received until BSY is cleared (μs) (Typical)
73-79	0000h		Reserved

Table 4.27 Device parameter information (3/6)

Word	Value	Bits	Description
80	0020h		Major Version number (ATA/ATAPI-5)
81	0015h		Minor Version number (ATA/ATAPI-5 T13 1321D revision 1)
82	4278h		Command set supported (A value of less than 1 indicates that the command is supported.)
		15	Unused (0b)
		14	NOP command (1b)
		13	READ BUFFER command (0b)
		12	WRITE BUFFER command (0b)
		11	Unused (0b)
		10	Host protect area function (0b)
		9	DEVICE RESET command (1b)
		8	SERVICE command interrupt (0b)
		7	Interrupt at release (0b)
		6	Read ahead cache (1b)
		5	Write cache (1b)
		4	Packet command function (1b)
		3	Power management function (1b)
		2	Removable media function (0b)
		1	Security mode (0b)
		0	SMART function (0b)
83	4010h		Command set supported (A value of less than 1 indicates that the command is supported.)
		15	0b.
		14	1b
		13-8	Reserved (0b)
		7	SET MAX security (0b)
		6	Spin up function after power-on with SET FEATURES command
		5	Power-up mode in standby status (0b)
		4	Removable media status notification function (1b)
		3-1	Reserved (0b)
		0	DOWNLOAD MICROCODE command supported (0b)
84	4000h		Command set supported
		15	0b

Table 4.27 Device parameter information (4/6)

Word	Value	Bits	Description
84		14	1b
		13-0	Reserved (0b)
85	4278h (Default value)		Command set supported and whether the function is enabled or disabled
			(A value of less than 1 indicates that the command is supported and enabled.)
		15	Unused (0b)
		14	NOP command support (1b)
		13	READ BUFFER command support (0b)
		12	WRITE BUFFER command support (0b)
		11	Unused (0b)
		10	Host protect area function support (0b)
		9	DEVICE RESET command support (1b)
		8	SERVICE command interrupt is enabled (0b)
		7	Interrupt at release is enabled (0b)
		6	Read ahead cache is enabled (1b: Default value)
		5	Write cache is enabled (1b: Default value)
		4	Packet command function support (1b)
		3	Power management function support (1b)
		2	Removable media function support (0b)
		1	Security mode enabled (0b)
		0	SMART function is enabled (0b)
86	0000h (Default value)		Command set supported and whether the function is enabled or disabled (A value of less than 1 indicates that the command is supported and enabled.)
		15-8	0b
		7	SET MAX security enabled (0b)
		6	Spin up function enabled after power-on with SET FEATURES subcommand (0b)
		5	Power-up mode enabled in standby status (0b)
		4	Removable media status notification function enabled (0b: Default value)
		3-1	Reserved (0b)
		0	DOWNLOAD MICROCODE command supported (0b)

Table 4.27 Device parameter information (5/6)

Word	Value	Bits	Description
87	4000h		Command set supported and whether the function is enabled or disabled
			(A value of less than 1 indicates that the command is supported and enabled.)
		15	0b
		14	1b
		13-0	Reserved
88	0007h	15-13	Reserved (0b)
	(Default value)	12	Ultra DMA transfer mode 4 is selected
		11	Ultra DMA transfer mode 3 is selected
		10	Ultra DMA transfer mode 2 is selected
		9	Ultra DMA transfer mode 1 is selected
		8	Ultra DMA transfer mode 0 is selected
		7-5	Reserved (0b)
		4	Ultra DMA transfer modes 4 or under are supported (0b)
		3	Ultra DMA transfer modes 3 or under are supported (0b)
		2	Ultra DMA transfer modes 2 or under are supported (1b)
		1	Ultra DMA transfer modes 1 or under are supported (1b)
		0	Ultra DMA transfer modes 0 is supported (1b)
89-92	0000h		Reserved
93	xxxxh	15	0b
		14	1b
		13	0b
			- for device 0
		12-8	0b
		7	0b
		6	1b (Responds when device 1 is selected)
		5	If DASP- is detected: 1b If not: 0b
		4	If PDIAG- is detected: 1b If not: 0b
		3	If diagnosis ends normally: 1b If an error occurred: 0b
		2-1	11b
		0	1b

Table 4.27 Device parameter information (6/6)

Word	Value	Bits	Description
93			
			- for device 1
		12	0b
		11	If PDIAG- is asserted: 1b If not: 0b
		10-9	11b
		8	1b
		7-0	0b
94-126	0000h		Reserved
127	0001h	15-2	Reserved (0b)
		1-0	Media status notification function supported (01b)
128	0000h	15-9	Reserved (0b)
		8	Security level (0b)
		7-6	Reserved (0b)
		5	Extended security erase supported (0b)
		4	Security count invalid (0b)
		3	Security freeze (0b)
		2	Security lock (0b)
		1	Security valid (0b)
		0	Security supported (0b)
129-254	0000h		Reserved
255	0000h	15-8	Cheek some (Unused)
		7-0	Signature (Unused)

4.5.7 IDLE IMMEDIATE (E1h)

Table 4.28 IDLE IMMEDIATE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	1	0	0	0	0	1
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The ODD sets the power mode to idle mode.

4.5.8 NOP (00h)

Table 4.29 NOP command

	Bit							
	7	6	5	4	3	2	1	0
CM	0	0	0	0	0	0	0	0
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The NOP command enables 16-bit access for Status register checking. The ODD judges an unsupported command. The command ends with Aborted Command.

4.5.9 PACKET (A0h)

Table 4.30 PACKET command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	1	0	0	0	0	0
DH	X	X	X	DEV	X	X	X	X
CH	Byte Count Limit (15-8)							
CL	Byte Count Limit (7-0)							
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The PACKET command issues the ATAPI packet command.

For the Byte Count Limit, specify the maximum number of bytes transferred per INTRQ in PIO mode.

When the value of the Byte Count Limit is smaller than 2048, the data is transferred in 2048-byte units.

The execution protocol of the ATAPI packet command conforms to the AT Attachment with Packet Interface - 5 (ATA/ATAPI-5) of the ANSI documents.

4.5.10 SET FEATURES (EFh)

Table 4.31 SET FEATURES command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	1	0	1	1	1	1
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	Setting value							
FR	Setting value							

The SET FEATURES command changes the ODD operating mode to the mode set in the SC and FR registers. If the specified value is not supported by the ODD or an invalid value, the ODD reports Aborted Command.

Table 4.32 FR register setting value

Setting value	Function	Default value
02	Enables the write cache.	*
03	Supports data transfer depending on the value of the SC register. See Table 4.33.	31
31	Disables the media status notification function.	*
55	Disables the read ahead cache.	
66	Does not reset various setting values to the power-on default value by software reset. (The media status notification function is reset normally.)	*
82	Disables the write cache.	
95	Enables the media status notification function.	
AA	Enables the read ahead cache.	*
CC	Returns various setting values to the power-on default value by software reset.	

Table 4.33 Transfer setting values in the SC register

Transfer mode	Bits 7 to 3	bits 2 to 0
PIO default transfer mode	00000	000
PIO default transfer mode (without IORDY signal)	00000	001
PIO flow control transfer mode (with IORDY signal)	00001	Mode
Undefined	00010	–
Multiword DMA transfer mode	00100	Mode
Ultra DMA transfer mode	01000	Mode
Undefined	10000	–
Mode indicates the number of transfer modes.		

When the FR register is 95h, the ODD responds with the following value at the end of the command.

Table 4.34 Cylinder Low register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Version (00h)							

Table 4.35 Cylinder High register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	PEJ (1)	LOCK (1)	PENA

PENA: Set to 1 when the media status notification function is enabled.

4.5.11 SLEEP (E6h)

Table 4.36 SLEEP command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	1	0	0	1	1	0
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The SLEEP command sets the ODD in sleep mode. The ODD enters sleep mode by following the steps given below.

1. The ODD spins down media.
2. The ODD issues an interrupt to the host to report command end. After the host receives the interrupt, the ODD deactivates the interface. Once the interface becomes inactive, the ODD ignores all resets except software reset and hardware reset and Device Reset command.

A software reset, or hardware reset or Device Reset command is required for a return from sleep mode.

Software reset is recommended for returning from sleep mode.

4.5.12 STANDBY IMMEDIATE (E0h)

Table 4.37 STANDBY IMMEDIATE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	1	0	0	0	0	0
DH	X	X	X	DEV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The ODD sets the power mode to standby mode.

4.6 Packet Commands

The ODD supports the packet commands listed below.

Table 4.38 Packet command codes and parameters

Command	Operation code	Section
ERASE (10)	2Ch	4.6.1
FORMAT UNIT	04h	4.6.2
INQUIRY	12h	4.6.3
MODE SELECT (6)	15h	4.6.4
MODE SELECT (10)	55h	4.6.5
MODE SENSE (6)	1Ah	4.6.6
MODE SENSE (10)	5Ah	4.6.7
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	4.6.8
READ (10)	28h	4.6.9
READ CAPACITY	25h	4.6.10
READ FORMAT CAPACITIES	23h	4.6.11
READ DEFECT DATA (10)	37h	4.6.12
READ DEFECT DATA (12)	B7h	4.6.13
READ LONG	3Eh	4.6.14
RECEIVE DIAGNOSTIC RESULTS	1Ch	4.6.15
REQUEST SENSE	03h	4.6.16
SEND DIAGNOSTIC	1Dh	4.6.17
SEEK (10)	2Bh	4.6.18
START STOP UNIT	1Bh	4.6.19
SYNCHRONIZE CACHE	35h	4.6.20
TEST UNIT READY	00h	4.6.21
VERIFY	2Fh	4.6.22
WRITE (10)	2Ah	4.6.23
WRITE AND VERIFY	2Eh	4.6.24
WRITE BUFFER	3Bh	4.6.25
WRITE LONG	3Fh	4.6.26

In this chapter, unless otherwise specified, the value of data marked as "Reserved" that is sent from the host is ignored. In addition, unless otherwise specified, 0 is returned to the data marked as "Reserved" that is sent from the device to the host.

However, if the data marked as "Reserved" is specified for a code value such as Page Code of the Mode Sense command, unless otherwise specified, Check Condition is returned.

4.6.1 ERASE command

Table 4.39 ERASE command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Ch)							
1	Reserved							
2-5	Logical Block Address							
6	Reserved							
7-8	Transfer Length							
9-11	Reserved							

The ERASE command erases data of the specified number of blocks from the specified logical block address.

Logical Block Address specifies the head logical block address from which the ODD starts writing.

Transfer Length specifies the number of blocks to be transferred and written.

When Transfer Length is specified as 0, the command does not carry out data transfer. The ERASE command erases no data of the blocks and ends normally.

4.6.2 FORMAT UNIT command

Table 4.40 FORMAT UNIT command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (04h)							
1	Reserved			FmtData	CmpList	Defect List Format		
2	Reserved							
3-4	Interleave							
5-11	Reserved							

The FORMAT UNIT command formats media physically on the basis of the specified parameter values.

When the FmtData bit is 1, the FORMAT UNIT parameter list must be transferred. Defect List Format is ignored.

When the FmtData bit is 0, the ODD does not transfer the FORMAT UNIT parameter list and formats media using the internal default values instead.

The CmpList is ignored.

The interleaving is set to the internal default value even if a value is specified.

Table 4.41 FORMAT UNIT parameter list

Bit Byte	7	6	5	4	3	2	1	0
0-3	Defect List Header							

Table 4.42 Defect list header

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved		DCRT	Reserved			IMMED	Reserved
2	Defect List Length							

When the DCRT (Disable Certification) bit is 1, the ODD formats media without checking it.

When the IMMED (Immediate) bit is 1, the ODD responds with immediate end after the command is received and before formatting is completed. At this time, during formatting, the Ready bit of the Status register is set to 0, and then set to1 after formatting is completed.

Defect List Length must be 0. If any other value is set, the command assumes as 0 is specified.

4.6.3 INQUIRY command

Table 4.43 INQUIRY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Allocation Length							
5-11	Reserved							

The INQUIRY command transfers device information to the host.

If the INQUIRY command is issued while the ODD contains the Unit Attention condition, the ODD responds normally, but does not clear the Unit Attention condition.

Table 4.44 INQUIRY data

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="3">Reserved</td><td colspan="5">Peripheral Device Type Optical memory Device (07h)</td></tr>
<tr><td>1</td><td>RMB
(1b)</td><td colspan="7">Reserved</td></tr>
<tr><td>2</td><td colspan="8">Version (04h)</td></tr>
<tr><td>3</td><td colspan="4">Reserved</td><td colspan="4">Response data format (2h)</td></tr>
<tr><td>4</td><td colspan="8">Additional length (2Bh)</td></tr>
<tr><td>5-7</td><td colspan="8">Reserved</td></tr>
<tr><td>8-15</td><td colspan="8">Vendor Information
"FUJITSU" (in ASCII)
Left justified. The rightmost data field not used is filled with space characters. (20h)</td></tr>
<tr><td>16-31</td><td colspan="8">Products Identification
"MCJ3230AP" (in ASCII)
Left justified. The rightmost data field not used is filled with space characters. (20h)</td></tr>
<tr><td>32-35</td><td colspan="8">Firmware Revision Level
"0000" - "999z" (in ASCII)</td></tr>
<tr><td>36</td><td colspan="8">Firmware Local Revision
00h - FFh (in HEX)</td></tr>
<tr><td>37</td><td colspan="8">Boot Firmware Revision Level
00h - FFh (in HEX)</td></tr>
<tr><td>38-39</td><td colspan="8">Signature
"MO" (in ASCII)</td></tr>
<tr><td>40-47</td><td colspan="8">Factory infomation</td></tr>
</table>

The Factory Information is the data for drive manufacturing factories. The data may vary depending on the device. Therefore, the host should not have an expected value. Normally return 0.

4.6.4 MODE SELECT (6) command

Table 4.45 MODE SELECT (6) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (15h)							
1	Reserved			PF	Reserved			SP
2-6	Reserved							
7-8	Parameter List Length							
9-11	Reserved							

The MODE SELECT (6) command sets various device operating modes.

The PF (Page Format) bit must be 1. If the PF bit is 0, the command responds with Check Condition.

When the SP (Save Pages) bit is 1, the ODD saves all parameter values transferred to the flash ROM.

Parameter List Length specifies the number of bytes in the mode parameters to be transferred. If it is 0, the command does not carry out transfer and ends normally.

If the transferred mode parameters are insufficient, the command responds with Check Conditions.

Table 4.46 lists mode parameters supported.

Table 4.46 Mode parameters

Definition	Page Code	Section
Read-Write Error Recovery Page	01h	4.6.4.1
Flexible Disk Page	05h	4.6.4.2
Caching Page	08h	4.6.4.3
Power Condition Page	1Ah	4.6.4.4
Verify Control Page	3Eh	4.6.4.5

Table 4.47 lists the mode parameter list.

Table 4.47 Mode parameter list

Bit Byte	7	6	5	4	3	2	1	0
0-4	Mode Parameter Header							
0-7	Block Descriptor							
0-n	Mode Page (s)							

The mode parameter list consists of a mode parameter header Block Descriptor and Mode Page (s). Table 4.48 lists the mode parameter header.

Table 4.48 Mode parameter header

Bit Byte	7	6	5	4	3	2	1	0
0	Mode Data Length							
1	Medium Type Code							
2	WP	Reserved						
3	Block Descriptor Length							

The values specified for Mode Data Length, Medium Type Code, and WP are ignored. Block descriptor Length must be 0 or 8.

Table 4.49 lists the block descriptors.

All the values specified for Block Descriptor are ignored.

Table 4.49 Block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Density Code (00h)							
1-3	Number of Blocks							
4	Reserved							
5-7	Block Length							

Table 4.50 lists the Mode Page format.

Table 4.50 Mode Page Format

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	Page Code					
1	Page Length (n-1)							
2-n	Mode Parameters							

4.6.4.1 Read-Write error recovery page

Table 4.51 Read-Write error recovery page

Bit Byte	7	6	5	4	3	2	1	0
0	PS (1)	0	Page Code (01h)					
1	Page Length (0Ah)							
2	AWRE	Reserved	Reserved	RC	Reserved	PER	Reserved	DCR
3	Read Retry Count							
4-7	Reserved							
8	Write Retry Count							
9-11	00h							

When the AWRE (Automatic Write Reallocation Enable) bit is 0, no automatic alternate block assignment is made for the WRITE (10), or WRITE AND VERIFY command. When the bit of AWRE is 1, automatic alternate block assignment is made.

When the RC (Read Continuous) bit is 0, the command reports an error if an uncorrectable data error is detected in the READ (10) command. When the bit of RC is 1, the command transfers the wrong data and ends normally even if an uncorrectable error is detected.

When the PER (Post Error) bit is 0, the command reports the GOOD status when it recovers the normal state by using the error recovery process. When the bit of PER is 1, the command reports the CHECK CONDITION status when it recovers the normal state by using the error recovery process. At this time, Sense key is set with RECOVERED ERROR.

RECOVERED ERROR is reported:

- When 7 to 8 error bytes per interleaving was corrected by the ECC correction during read operation
- When a defect sector is detected and replaced with an alternate sector during a write operation
- When an error occurs in one of four sets of media data during media management information (DMA) write operation with the FORMAT UNIT command (MEDIUM ERROR is set if an error occurs in two, three, or four sets of four sets.)

When the DCR (Disable Correction) bit is 0, the command corrects errors if a correctable error is detected in the READ (10) command. When the bit of DCR is 1, the command does not correct errors even if a correctable error is detected.

Read Retry Count must not be 3 or smaller. If a value of 3 or smaller is specified, the command assumes 4 and reports Recovered Error.

Write Retry Count must not be a value other than 3. If a value other than 3 is specified, the command assumes 3 and reports Recovered Error.

To assure media compatibility, the read-write error recovery page should be set to the default value, except for diagnostics purposes.

The read-write error recovery page can be saved.

Table 4.52 Changeable values in the read-write recovery page

Bit Byte	7	6	5	4	3	2	1	0
2	1	0	0	1	0	1	0	1
3	FFh							
4-7	00h							
8	FFh							
9-11	00h							

Table 4.53 Default values for the read-write recovery page

Bit Byte	7	6	5	4	3	2	1	0
2	1	0	0	1	0	1	0	1
3	3Fh							
4-7	00h							
8	03h							
9-11	00h							

4.6.4.2 Flexible disk page

Table 4.54 Flexible disk page

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	Page Code (05h)					
1	Page Length (1Eh)							
2-3	Transfer Rate							
4	Number of Heads							
5	Sectors per Track							
6-7	Data Bytes per Sectors							
8-9	Number of Cylinders							
10-19	Reserved							
20	Motor off Delay							
21-27	Reserved							
28-29	Medium Rotation Rate							
30-31	Reserved							

This page is supported for compatibility of device driver.

Recommendation: A device driver should not be used this page, because if device driver uses of this page and it is not able to keep compatibility for logically of media (No guarantee).

"Transfer Rate" defines "kbits/sec".

"Number of Heads, Sectors per Track and Number of Cylinders" define logical value. It does not show physical numbers. No guarantee for logical compatibility of media when device driver or application is used this value.

"Data Bytes per Sectors" defines Block Length (200h or 800h).

"Motor off Delay" defines time for spinning down operation. X'FF' is to does not stop motor forever.

"Medium Rotation Rate" defines revolutions per minute.

Table 4.55 Changeable values in flexible disk page

Bit Byte	7	6	5	4	3	2	1	0
2-3	0000h							
4	00h							
5	00h							
6-7	00h							
8-9	0000h							
10-19	0000h							
20	00h							
21-27	00h							
28-29	0000h							
30-31	00h							

Table 4.56 Default values in flexible disk page

Bit Byte	7	6	5	4	3	2	1	0
2-3	3E80h							
4	40h							
5	20h							
6-7	In case of 640 Mbytes, 1.3 Gbytes and 2.3 Gbytes media = 800h Others or Not Ready = 200h							
8-9	Number of LBA for media / (40h × 20h) In case of Not Ready = the value of the maximum capacity media among the supported 512 sectors media							
10-19	00h							
20	FFh							
21-27	00h							
28-29	1194h							
30-31	00h							

4.6.4.3 Caching page

Table 4.57 Caching page

Bit Byte	7	6	5	4	3	2	1	0
0	PS (1)	0	Page Code (08h)					
1	Page Length (12h)							
2	Reserved					WCE	Reserved	RCD
3-19	Reserved							

When the WCE (Write Cache Enable) bit is 0, the write cache function for the WRITE (10), or WRITE AND VERIFY command is disabled. When the bit of WCE is 1, the write cache function is enabled.

When the RCD (Read Cache Disable) bit is 0, the read ahead cache function for the READ (10) command is enabled. When the bit of RCD is 1, the read ahead cache function is disabled.

The caching page can be saved.

Table 4.58 Changeable values in the caching page

Bit Byte	7	6	5	4	3	2	1	0
2	0	0	0	0	0	1	0	1
3-19	00h							

Table 4.59 Default values for the caching page

Bit Byte	7	6	5	4	3	2	1	0
2	0	0	0	0	0	1	0	0
3-19	00h							

4.6.4.4 Power Condition page

Table 4.60 Power Condition Page

Bit Byte	7	6	5	4	3	2	1	0
0	PS (1)	0	Page Code (1Ah)					
1	Page Length (0Ah)							
2	Reserved							
3	Reserved						Idle	Standby
4-7	Idle Condition Timer (in 100-ms unit)							
8-11	Standby Condition Timer (in 100-ms unit)							

The values specified for the Idle bit and Idle Condition Timer are ignored. It always operates in accordance with the default timer value in the ODD.

When the Standby bit is 1, specify the time after the device enters idle mode until it enters standby mode.

The Idle Condition Timer value and the Standby Condition Timer value are specified with a value in 100-ms units.

If the value specified for the Standby Condition Timer is not a multiple of 600 (258h), the ODD automatically rounds down the fractions to a value in 60-second units.

Power Condition Page can be saved.

Table 4.61 Power Condition Page Variable

Bit Byte	7	6	5	4	3	2	1	0
2	0							
3	0						0	1
4-7	0							
8-11	ffffffffh							

Table 4-62 Power Condition Page Default value

Bit Byte	7	6	5	4	3	2	1	0
2	0							
3	0						1	1
4-7	00000708h							
8-11	000043F8h							

4.6.4.5 Verify Control Page

Table 4-63 Verify Control Page

Bit Byte	7	6	5	4	3	2	1	0
0	PS (1)	0	Page Code (3Eh)					
1	Page Length (06h)							
2	AV	SM	Reserved				VM	
3	Reserved			DevType				
4-7	Reserved							

The Verify Control Page is a vendor unique page.

When the Audio Visual Mode (AV) bit is 0, the cache mode is applied. When the AV bit is 1, the AV data support mode is applied.

When the Streaming Mode (SM) bit is 0, the test write operation may interrupt the read or write operation. When the SM bit is 1, the test write operation is restricted during the read or write operation. We recommend setting 0 for the SM bit.

The Verify Mode (VM) specifies the verify operation for the WRITE command.

Table 4.64 Verify Mode

VM	Description
0	Always executes the Verify operation.
1	Never executes the Verify operation.
2	Depending on the condition (Verify Skip Mode)
3	Reserved

The DevType specifies the Device Type value that is provided in response to the Identify command and the Identify Packet Device command. To validate the specified value, instruct the system to save the specification, and power on again.

The Verify Control Page can be saved.

Table 4.65 Verify Control Page variable

Bit Byte	7	6	5	4	3	2	1	0
2	1	1	0				11b	
3	0			1Fh				
4-7	0							

Table 4.66 Verify Control Page default value

Bit Byte	7	6	5	4	3	2	1	0
2	1	0	0				00b	
3	0			0h				
4-7	0							

4.6.5 Mode Select (10) command

Table 4.67 Mode Select (10) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (55h)							
1	Reserved			PF	Reserved			SP
2-6	Reserved							
7-8	Parameter List Length							
9-11	Reserved							

The MODE SELECT (10) command performs the same processing as the MODE SELECT (6) command.

For an explanation of each field, see the MODE SELECT (6) command.

For information about the supported mode page, see Table 4.46, Mode Page Codes.

Table 4.68 shows the Mode Parameter List.

Table 4.68 Mode Parameter List

Bit Byte	7	6	5	4	3	2	1	0
0-7	Mode Parameter Header							
0-7	Block Descriptor							
0-n	Mode Page (s)							

The Mode Parameter List consists of the Mode Parameter Header, the Block Descriptor, and the Mode Page. Table 4.69 shows the mode parameter header.

Table 4.69 Mode Parameter Header

Bit Byte	7	6	5	4	3	2	1	0
0-1	Mode Data Length							
2	Medium Type Code							
3	WP	Reserved						
4-5	Reserved							
6-7	Block Descriptor Length							

The values specified for the Mode Data length, the Medium Type Code, and the WP are ignored.

For the Block Descriptor and the Mode Page, see Section 4.6.4, MODE SELECT (6) command.

4.6.6 MODE SENSE (6) command

Table 4.70 MODE SENSE (6) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Ah)							
1	Reserved				DBD	Reserved		
2	PC		Page Code					
3	Reserved							
4	Allocation Length							
5-11	Reserved							

The MODE SENSE (6) command transfers the mode parameter list to the host.

When the Disable Block Descriptors (DBD) is 1, the Block Descriptor is not returned. When the DBD is 0, the Block Descriptor is returned. The Allocation Length specifies the number of bytes of the mode parameter to be transferred. When the Allocation Length is 0, this command is terminated normally without transferring data.

The Page Control (PC) specifies the type of the Page to be transferred.

Table 4.71 Page Control field

Bit 7	Bit 6	Parameter type
0	0	Current value
0	1	Changeable value
1	0	Default value
1	1	Saved value

Page Code specifies the Mode Page to be transferred. If Page Code is 3Fh, all Mode Pages are transferred. For page descriptors supported, see Table 4.46.

Mode pages are transferred in ascending page code order.

When 0 is specified for both the Page Code and the Page Control, the Mode Parameter Header and the Block Descriptor (only when the DBD bit is 0) are transferred.

Table 4.72 shows the mode parameter list.

Table 4.72 Mode parameter list

Bit Byte	7	6	5	4	3	2	1	0
0-4	Mode Parameter Header							
0-7	Block Descriptor							
0-n	Mode Page (s)							

The mode parameter list consists of a mode parameter header and Block Descriptor and Mode Page. The mode parameter header is shown in Table 4.73.

Table 4.73 Mode parameter header

Bit Byte	7	6	5	4	3	2	1	0
0	Mode data Length							
1	Medium Type Code							
2	WP	Reserved						
3	Block Descriptor Length							

Medium Type Code returns the following values:

- 03h for non overwrite
- 07h for overwrite
- 03h for other media and Not Ready state

The WP (Write Protect) bit indicates the state of the write protect key on the cartridge. A value of 1 indicates write protected

Mode Data Length indicates the length of mode data to be transferred

Block Descriptor Length indicates the length of block descriptor to be transferred in bytes.

The Block descriptor is shown in Table 4.74.

Table 4.74 Block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Density Code (00h)							
1-3	Number of Block							
4	Reserved							
5-7	Block Length							

Each field value of the Block Descriptor is validated only when the accessible media is inserted. If not, 0 is returned.

Table 4.75 shows the mode page format.

Table 4.75 Mode Page Format

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	Page Code					
1	Page length (n-1)							
2-n	Reserved							

A value of 1 in PS indicates that the page descriptor can be saved on the Flash ROM.

4.6.7 MODE SENSE (10) command

Table 4.76 MODE SENSE (10) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Ah)							
1	Reserved				DBD	Reserved		
2	PC		Page Code					
3-6	Reserved							
7-8	Allocation length							
9-11	Reserved							

The MODE SENSE (10) command performs the same processing as the MODE SENSE (6) command.

For an explanation of each field, see Section 4.6.6, MODE SENSE (6) command.

Table 4.77 shows the mode parameter list.

Table 4.77 Mode Parameter List

Bit Byte	7	6	5	4	3	2	1	0
0-7	Mode Parameter Header							
0-7	Block Descriptor							
0-n	Mode Page (s)							

The Mode Parameter List consists of the Mode Parameter Header, the Block Descriptor, and the Mode Page.

Table 4.7.8 shows the mode parameter header.

Table 4.78 Mode Parameter Header

Bit Byte	7	6	5	4	3	2	1	0
0-1	Mode Data Length							
2	Medium Type Code							
3	WP	Reserved						
4-5	Reserved							
6-7	Block Descriptor Length							

For an explanation of each field of the Mode Parameter Header, an explanation of the Block Descriptor and an explanation of Mode Page, see Section 4.6.6, MODE SENSE (6) command.

4.6.8 PREVENT/ALLOW MEDIUM REMOVAL command

Table 4.79 PREVENT/ALLOW MEDIUM REMOVAL command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Eh)							
1	Reserved							
2-3	Reserved							
4	Reserved							Prevent
5-11	Reserved							

The PREVENT/ALLOW MEDIUM REMOVAL command allows or inhibits media ejection on the device.

A value of 0 in the Prevent bit allows ejection and a value of 1 disables ejection.

The power-on default value is Enabled.

If there is any data not written yet in the write cache, the ODD completes writing on media, then allows ejection.

Hard reset resets the prevent state to allow ejection.

Table 4.80 Response to Prevent/Allow/Eject

Operation	Status at operation	When no media is loaded	When media is loaded
Prevent = 0	Enabled	No error	No error
	Inhibited	No error	No error
Prevent = 1	Enabled	No error	No error. Media ejection is inhibited.
	Inhibited	No error	No error
Eject	Enabled	No error	No error: Eject the cartridge
(Ejection with START/STOP UNIT command)	Inhibited	Error: SENSE KEY 5 ASC/ASCQ 5302	Error: SENSE KEY 5 ASC/ASCQ 5302
Eject	Enabled	The state remains unchanged.	Eject the cartridge
(Ejection with the Eject switch)	Inhibited	The state remains unchanged.	The state remains unchanged. Media ejection is still inhibited.

4.6.9 READ (10) command

Table 4.81 READ (10) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (28h)							
1	Reserved							
2-5	Logical Block Address							
6	Reserved							
7-8	Transfer Length							
9-11	Reserved							

The READ (10) command reads data for the specified number of blocks from the specified logical block address and transfers it.

Logical Block Address specifies the head logical block address used to start reading.

Transfer Length specifies the number of blocks to be read and transferred.

When Transfer Length is 0, the command does not carry out data transfer. It simply ends normally without reading any data.

4.6.10 READ CAPACITY command

Table 4.82 READ CAPACITY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (25h)							
1	Reserved							
2-7	Reserved							
8	Reserved							PMI
9-11	Reserved							

The READ CAPACITY command transfers data on the media capacity to the host.

The PMI (Partial Medium Indicator) bit specified value is ignored.

Table 4.83 lists the READ CAPACITY data to be transferred.

Table 4.83 READ CAPACITY data

Bit Byte	7	6	5	4	3	2	1	0
0-3	Last Logical Block Address							
4-7	Block Length in Bytes							

Last Block Address specifies LBA of the last accessible block.

Block Length in Bytes indicates the number of bytes per block.

4.6.11READ FORMAT CAPACITIES command

Table 4.84 READ FORMAT CAPACITIES command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (23h)							
1	Reserved							
2-6	Reserved							
7-8	Allocation Length							
9-11	Reserved							

The READ FORMAT CAPACITIES command transfers data on the capacity of media currently loaded to the host. If no media is loaded, this command returns the maximum capacity value of supported media to the host.

Table 4.85 READ FORMAT CAPACITIES data format

Bit Byte	7	6	5	4	3	2	1	0
	Capacity List Header							
	Current / Maximum Capacity Descriptor							

Table 4.86 Capacity list header

Bit Byte	7	6	5	4	3	2	1	0
0-2	Reserved							
3	Capacity List Length (8h)							

Capacity List Length indicates the length of the capacity descriptor in bytes.

Table 4.87 Current/Maximum capacity descriptor

Bit Byte	7	6	5	4	3	2	1	0
0-3	Number of Blocks							
4	Reserved						Descriptor Code	
5-7	Block Length							

Number of Blocks indicates the number of addressable blocks.

Descriptor Code indicates the type of descriptor to be reported to the host.

Block Length indicates the length of the block in bytes.

Table 4.88 Descriptor code definition

Descriptor Code	Descriptor Type
00b	Unformatted media (Other fields are ineffective.)
01b	Unformatted media (Maximum format capacity)
10b	Formatted media (Current media capacity)
11b	No media loaded (Maximum format capacity)

4.6.12 READ DEFECT DATA (10) command

Table 4.89 READ DEFECT DATA (10) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (37h)							
1	Reserved							
2	Reserved			Plist	Glist	Defect List Format		
3-6	Reserved							
7-8	Allocation Length							
9-11	Reserved							

The READ DEFECT DATA command transfers media defect data to the host.

When Plist is 1, the command transfers header and PDL. When Glist is 1, this command transfers header and SDL. When both Plist and Glist are 0, it transfers the header. When both Plist and Glist are 1, the command transfers PDL and SDL. PDL and SDL are arranged in an ascending order.

The defect list format supported is listed in Table 4.90. If any other format is specified, the command assumes 101b and reports Recovered Error.

Table 4.90 Defect List Format - READ DEFECT DATA (10)

Defect List Format	Data format
101	Physical sector address format (Up to 8191 in the defect list)
111	Physical sector address format (8192 or later in the defect list)

Table 4.91 shows the defect list header. Table 4.92 shows the defect descriptors.

Table 4.91 Defect List Header - READ DEFECT DATA (10)

Bit Byte	7	6	5	4	3	2	1	0
0	00h							
1	0	0	0	Plist	Glist	Defect List Format		
2-3	Defect List Length							
4-n	Defect Descriptor (s)							

Table 4.92 Defect Descriptor

Byte	Defect Descriptor
0-2	Defect block track address
3	00h
4-7	Defect block sector address See Table 4.93, Sector Address Format.

Table 4.93 Sector Address Format

Bit / Byte	7	6	5	4	3	2	1	0
0-2	00h							
3	0	For disks other than 2.3 GB: 00b For 2.3-GB disks: 00b Groove 10b Land		Sector Address				

4.6.13 READ DEFECT DATA (12) command

Table 4.94 READ DEFECT DATA (12) command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (B7h)							
1	Reserved			Plist	Glist	Defect List Format		
2-5	Reserved							
6-9	Allocation Length							
10-11	Reserved							

The READ DEFECT DATA (12) command transfers the defect data to the host.

When Plist is 1, the command transfers header and PDL. When Glist is 1, the command transfers header and SDL. When both Plist and Glist are 0, the command transfers the header. When both Plist and Glist are 1, the command transfers PDL and SDL. PDL and SDL are respectively arranged in an ascending order.

The defect list format supported is listed in Table 4.95, Defect List Format - READ DEFECT DATA (12). If any other format is specified, the command assumes 101b and reports Recovered Error.

Table 4.95 Defect List Format - READ DEFECT DATA (12)

Defect List Format	Data format
101	Physical sector address format

The defect list header is listed in Table 4.96, Defect List Header - READ DEFECT DATA (12). Table 4.92 shows the defect descriptor.

Table 4.96 Defect List Header - READ DEFECT DATA (12)

Bit Byte	7	6	5	4	3	2	1	0
0	00h							
1	0	0	0	Plist	Glist	Defect List Format		
2-3	00h							
4-7	Defect List Length							
8-n	Data Descriptor (s)							

4.6.14 READ LONG command

Table 4.97 READ LONG command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Eh)							
1	Reserved							
2-5	Logical Block Address							
6	Reserved							
7-8	Byte Transfer Length							
9-11	Reserved							

The READ LONG command reads data in the data, CRC, and ECC sections from the specified logical block address.

The transfer byte length must be a multiple of 600 (258h) bytes for 512 byte media and a multiple of 2380 (94Ch) bytes for 2048 byte media.

4.6.15 RECEIVE DIAGNOSTIC RESULTS command

Table 4.98 RECEIVE DIAGNOSTIC RESULTS command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Ch)							
1	Reserved							
2	Reserved							
3-4	Allocation Length							
5-11	Reserved							

The RECEIVE DIAGNOSTIC RESULTS command transfers the diagnostic results indicated by the SEND DIAGNOSTIC command to the host. The RECEIVE DIAGNOSTC RESULT command must be issued following the SEND DIAGNOSTIC command. If not issued continuously or if there is no data to be transferred, the command transfers no data and ends normally.

4.6.16 REQUEST SENSE command

Table 4.99 REQUEST SENSE command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (03h)							
1	Reserved							
2-3	Reserved							
4	Allocation Length							
5-11	Reserved							

The REQUEST SENSE command transfers sense data to the host. Sense data indicates detailed error information on the command whose error was reported previously. If no error command was reported, SENSE KEY indicates NO SENSE.

When issuing the REQUEST SENSE command to detect the device status, first issue the TEST UNIT READY command, then issue REQUEST SENSE.

Allocation Length indicates the length of sense data to be transferred in bytes. If Allocation Length is 0, the command transfers no data and ends normally.

When the ODD detects a CRC error involving the Ultra DMA transfer during the data transfer using this command, it returns the CHECK CONDITION. (The Sense Key of the Error register indicates ABORTED COMMAND.)

The original sense data at the CRC error occurrence is reported normally using the REQUEST SENSE command. Otherwise, it will be reported when another command is received.

The sense data format is shown in Table 4.100.

Table 4.100 Request sense data

Bit Byte	7	6	5	4	3	2	1	0
0	Valid	Error Code (70h or 71h)						
1	Reserved (00h)							
2	Reserved (0h)				Sense Key			
3-6	Information							
7	Additional Sense Length (18h)							
8-11	Command-Specific Information							
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Reserved (00h)							
15-17	Sense-key specific							
18-31	Additional Sense Bytes							

When the Valid bit is 1, the information field (bytes 3 to 6) is effective.

Error Code indicates the sense data format and type. See Table 4.101.

Table 4.101 Error code

Error Code	Report timing
70h (Current error)	Reported for a normal error.
71h(Deferred error)	Reported when an error occurs in the command that accesses the write cache when the write cache is enabled. If this sense data is reported, the command that reported the Check Condition status is not executed.

Sense Key outlines the error. The definition of Sense Key is listed in Table 4.102.

Table 4.102 Sense Key code

Sense Key	Abbreviation	Definition
0h	NO SENSE	Indicates there is no sense key to be reported. NO SENSE is set when a command ends normally.
1h	RECOVERED ERROR	Indicates that recovery ends successfully or that the command ends normally using the internal default value even if invalid data is detected in command parameters. (Not reported when the PER bit is 0.)
2h	NOT READY	Indicates that access with an access command cannot be executed.
3h	MEDIUM ERROR	Indicates that an unrecoverable error is detected due to media failure.
4h	HARDWARE ERROR	Indicates that an unrecoverable error is detected due to hardware failure.
5h	ILLEGAL REQUEST	Indicates that command packets or command parameters contains invalid data. Media data remains unchanged.
6h	UNIT ATTENTION	Indicates that reset, power-on, or media exchange is caused.
7h	DATA PROTECT	Indicates that media is write-protected with the Write Protect key or the device is softwre-write-protected.
8h	BLANK CHECK	Indicates that a blank sector is detected. Not used
9h-Ah	Reserved	Not used
Bh	ABORTED COMMAND	Indicates that the command is interrupted.
Ch-Fh	Reserved	Not used

The information indicates LBA of an error block. If an error occurs in multiple blocks, the LBA of the first block is indicated.

Command-Specific Information indicates the logical track address of the block indicated in Information (or logical block address). The track address format is shown in Table 4.103.

Table 4.103 Logical block address format

Byte	Description
8-9	Logical track address
10	00H
11	Logical sector address

Additional Sense Code (ASC)/Additional Sense Code Qualifier (ASCQ) indicates detailed error information. The definition of ASC/ASCQ is shown in Table 4.104.

Table 4.104 ASC/ASCQ list (1/2)

Sense Key	ASC	ASCQ	Error description
2	04	00	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
2	04	04	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS
3	09	00	TRACK FOLLOWING ERROR
4	08	03	LOGICAL UNIT COMMUNICATION CRC ERROR
3	09	01	TRACKING SERVO ERROR
3	0C	00	WRITE ERROR
3	0C	02	WRITE ERROR/AUTO REALLOCATION FAILED
3	10	00	ID CRC ERROR
3	11	00	UNRECOVERED READ ERROR
3	15	02	POSITIONING ERROR DETECTED BY READ OF MEDIUM
1	17	06	RECOVERED DATA WITHOUT ECC/DATA AUTO REALLOCATED
1	18	00	RECOVERED DATA WITH ERROR CORRECTION & RETRIES APPLIED
1	19	00	DEFECT LIST ERROR
3	19	01	DEFECT LIST NOT AVAILABLE
3	19	02	DEFECT LIST ERROR IN PRIMARY LIST
3	19	03	DEFECT LIST ERROR IN SECONDARY LIST
1	1C	00	DEFECT LIST NOT FOUND
5	20	00	INVALID COMMAND OPERATION CODE
5	21	00	LOGICAL BLOCK ADDRESS OUT RANGE
5	24	00	INVALID FIELD IN COMMAND PACKET
5	25	00	LOGICAL UNIT NOT SUPPORTED
5	26	00	INVALID FIELD IN PARAMETER LIST
7	27	00	WRITE PROTECTED
6	28	00	NOT READY TO READY TRANSITION, MEDIUM MAY HAVE CHANGED
6	29	00	POWER ON, RESET, DEVICE RESET OCCURRED

Table 4.104 ASC/ASCQ list (2/2)

Sense Key	ASC	ASCQ	Error description
3	30	00	INCOMPATIBLE MEDIUM INSTALLED
3	30	01	CANNOT READ MEDIUM/UNKNOWN FORMAT
3	31	00	MEDIUM FORMAT CORRUPTED
3	31	01	FORMAT COMMAND FAILED
3	32	00	NO DEFECT SPARE LOCATION AVAILABLE
3	32	01	DEFECT LIST UPDATE FAILURE
1	37	00	ROUNDED PARAMETER
2	3A	00	MEDIUM NOT PRESENT
4	40	NN	DIAGNOSTIC FAILURE ON COMPONENT NN
4	44	00	INTERNAL TARGET FAILURE
4	4A	00	COMMAND PHASE ERROR
4	4B	00	DATA PHASE ERROR
B	4E	00	OVERLAPPED COMMAND ATTEMPTED
4	53	00	MEDIA LOAD OR EJECT FAILED
5	53	02	MEDIUM REMOVAL PREVENTED
4	83	00	THERMAL ERROR

The Sense-Key Specific field format is shown in Table 4.105. Format Progress Indication Bytes is effective only when Sense key is NOT READY and the SKSV bit is 1. Otherwise, the field is set with 00h. This field is defined for the FORMAT UNIT command having the Immed bit of 1.

Table 4.105 Format Progress Indication Bytes

Bit Byte	7	6	5	4	3	2	1	0
15	SKSV	Reserved						
16-17	Progress Indication							

Progress Indication indicates the formatting completion rate when the denominator is 65536 (10000h).

Additional Sense Bytes indicates the detailed error code. For repairs, Additional Sense Bytes is recommended to be defined.

4.6.17 SEND DIAGNOSTIC command

Table 4.106 SEND DIAGNOSTIC command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	Reserved					SelfTest	Reserved	Reserved
2	Reserved							
3-4	Parameter List Length							
5-11	Reserved							

The SEND DIAGNOSTIC command instructs diagnostic operation from the host.

When the Self-Test bit is 1, the command executes diagnostics on the data buffer. If an error occurs, the device responds with Check Condition.

Parameter List Length specifies the data length of diagnostic parameters to be transferred.

The functions and specifications of diagnostic parameters are not open.

4.6.18 SEEK command

Table 4.107 SEEK command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	Reserved							
2-5	Logical Block Address							
6-11	Reserved							

The SEEK command positions the head on the track at the specified logical block address.

Logical Block Address specifies the logical block address at which the head is positioned.

4.6.19 START/STOP UNIT command

Table 4.108 START/STOP UNIT command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Bh)							
1	Reserved							IMMED
2-3	Reserved							
4	Reserved						LoEj	Start
5-11	Reserved							

The START/STOP UNIT command ejects media or starts and stops rotating the disk.

When the IMMED (Immediate) bit is 1, command completion is reported before processing is completed.

Processing for other values is listed in Table 4.109.

Table 4.109 START/STOP/EJECT processing

LoEj	Start	Processing
0	0	Stops disk rotation.
0	1	Starts disk rotation and checks the format type of media.
1	0	Ejects media if possible.
1	1	Ends abnormally (ILLEGAL REQUEST).

4.6.20 SYNCHRONIZE CACHE command

Table 4.110 SYNCHRONIZE CACHE command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (35h)							
1	Reserved						IMMED	Reserved
2-5	Logical Block Address							
6	Reserved							
7-8	Number of Blocks							
9-11	Reserved							

The SYNCHRONIZE CACHE command writes cache memory data not written yet in the data buffer to media.

The IMMED (Immediate) bit is not supported. When the IMMED bit is 1, the command responds with Check Condition.

The command writes all data not written yet in the cache memory of the data buffer to media, regardless of the value set in Logical Block Address and Number of Blocks. The command does not check the value of Logical Block Address and Number of Blocks.

4.6.21 TEST UNIT READY command

Table 4.111 TEST UNIT READY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (00h)							
1-11	Reserved							

The TEST UNIT READY command checks if the device is ready for test and reports the device status to the host.

If the ODD can end normally for appropriate access commands, the command responds with the Good status. Otherwise, the command responds with Check Condition to the host.

4.6.22 VERIFY command

Table 4.112 VERIFY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Fh)							
1	Reserved						ByteChk	Reserved
2-5	Logical Block Address							
6	Reserved							
7-8	Verification Length							
9-11	Reserved							

The VERIFY command verifies for the specified number of blocks from the specified logical block address.

Logical Block Address specifies the head logical block address from which verification starts.

Verification Length specifies the number of blocks to be verified and transferred.

When Verification Length is 0, the command verifies no block and ends normally.

The ByteChk bit indicates data compare execution. However, since the ByteChk is not supported, it must be set to 0. If a value 1 is specified, the command ends with Check Condition.

4.6.23 WRITE (10) command

Table 4.113 WRITE (10) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Ah)							
1	Reserved							
2-5	Logical Block Address							
6	Reserved							
7-8	Transfer Length							
9-11	Reserved							

The WRITE (10) command receives and writes data for the specified number of blocks from the specified logical block address.

Logical Block Address specifies the head logical block address used to start writing.

Transfer Length specifies the number of blocks to be transferred and written.

When Transfer Length is 0, the command does not carry out data transfer. It simply ends normally without writing any data.

4.6.24 WRITE AND VERIFY command

Table 4.114 WRITE AND VERIFY command

<table>
<tr><td>Bit
Byte</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>0</td><td colspan="8">Operation Code (2Eh)</td></tr>
<tr><td>1</td><td colspan="3">Logical Unit Number</td><td colspan="3">Reserved</td><td>ByteChk</td><td>Reserved</td></tr>
<tr><td>2-5</td><td colspan="8">Logical Block Address</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7-8</td><td colspan="8">Transfer Length</td></tr>
<tr><td>9-11</td><td colspan="8">Reserved</td></tr>
</table>

The WRITE AND VERIFY command receives and writes data for the specified number of blocks from the specified logical block address.

Logical Block Address specifies the head logical block address used to start writing.

Transfer Length specifies the number of blocks to be transferred and written.

The ByteChk bit indicates data compare execution. However, since the ByteChk is not supported, it must be set to 0. If a value 1 is specified, the command ends with Check Condition.

When Transfer Length is 0, the command does not carry out data transfer. It simply ends normally without writing any data.

4.6.25 WRITE BUFFER command

Table 4.115 WRITE BUFFER command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Bh)							
1	Reserved					Mode		
2	Reserved	Reserved	TNFY	Reserved	Code-ID			
3-5	Buffer Offset							
6-8	Allocation Length							
9-11	Reserved							

The WRITE BUFFER command downloads the firmware to the flash ROM.

Mode must be set to 5. Otherwise, the command responds with Check Condition.

If TNFY is 0 and Allocation Length is not 0, the command transfers data to be written on the flash ROM to the data buffer. The WRITE BUFFER command checks for validity of transfer data, then writes it on the flash ROM.

If TNFY is 0 and Allocation Length is 0, the command checks propriety of data on the data buffer and writes on the flash ROM.

When TNFY is 1, the command transfers data to be written on the flash ROM into the data buffer.

Code-ID indicates the type of code to be downloaded.

Allocation Length indicates the length of data to be transferred in bytes.

Buffer Offset indicates the offset value for data to be transferred.

If write operation to the flash ROM ends abnormally, the command responds with Check Condition.

IMPORTANT

If power failure or interface cable disconnection occurs during downloading, flash ROM data may not be assured.

Valid download data is Fujitsu distributed data only.

4.6.26 WRITE LONG command

Table 4.116 WRITE LONG command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Fh)							
1	Reserved							
2-5	Logial Block Address							
6	Reserved							
7-8	Byte Transfer Length							
9-11	Reserved							

The WRITE LONG command writes data in the data, CRC, and ECC sections to the specified logical block address.

The transfer byte length must be a multiple of 600 (258h) bytes for 512 byte media and a multiple of 2380 (94Ch) bytes for 2048 byte media.

4.7 Timing

4.7.1 Register/PIO data transfer timing

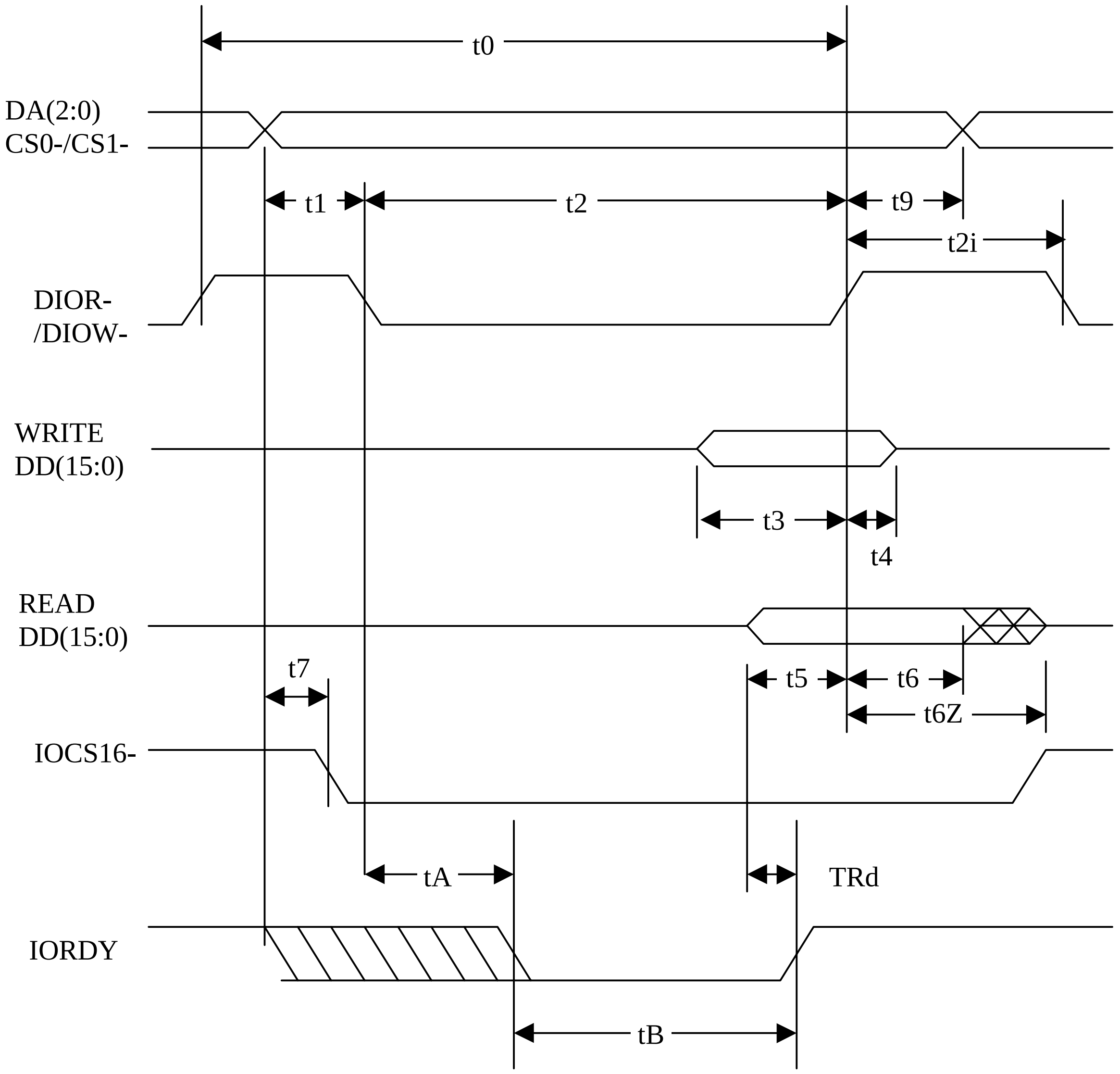


Figure 4.2 Register/PIO data transfer

Table 4.117 Register/PIO data transfer timing parameters

Symbol	Timing parameter	min (Units: ns)	max (Units: ns)	Condition
t0	Cycle time	120	-	At mode 4, no wait
t1	DIOR-/DIOW- setup time	25	-	
t2	DIOR-/DIOW- pulse width	70	-	
t2i	DIOR-/DIOW- recovery time	25	-	
t3	DIOW- data setup time	20	-	
t4	DIOW- data hold time	10	-	
t5	DIOR- data setup time	20	-	
t6	DIOR- data hold time	5	-	
t6Z	DIOR- data High –Z time	-	30	
t7	From address decided to IOCS16- asserted	-	30	
t8	From address decided to IOCS16- released	-	30	
t9	DIOR-DIOW- to address valid hold time	10	-	
tA	IORDY setup time	-	35	PIO flow control transfer mode
tB	IORDY pulse width	-	1250	PIO flow control transfer mode
tRd	Read data valid to IORDY active	0	-	

4.7.2 Multiword DMA data transfer timing

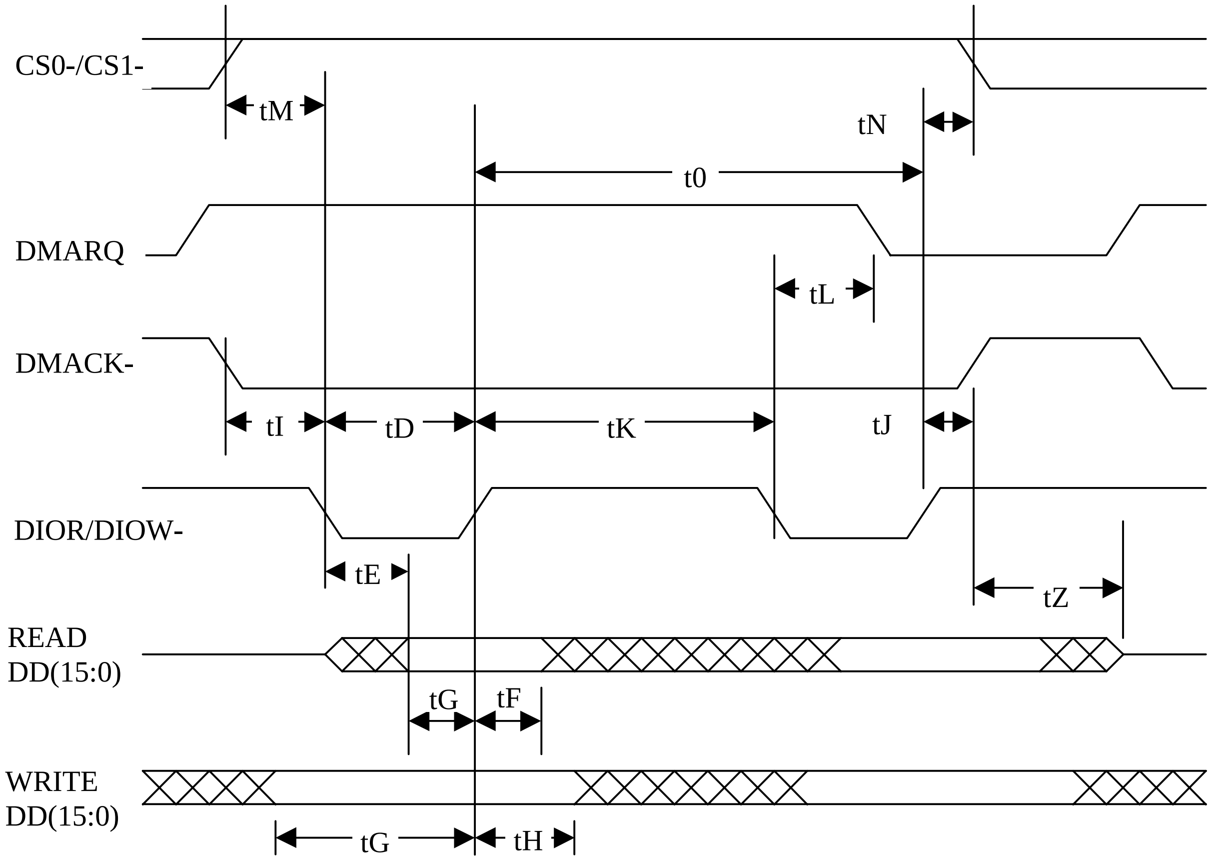


Figure 4.3 Multiword DMA data transfer

Table 4.118 Multiword DMA data transfer timing parameters

Symbol	Timing parameter	min (Units: ns)	max (Units: ns)	Condition
t0	Cycle time	120	-	Mode 2
tD	DIOR-/DIOW- pulse width	70	-	
tE	DIOR- data access time	50	-	
tF	DIOR- data hold time	5	-	
tG	DIOR-/DIOW- data setup time	20	-	
tH	DIOW- data hold time	10	-	
tI	DMACK- to DIOR/DIOW- setup time	0	-	
tJ	DIOR-/DIOW to DMACK- hold time	5	-	
tK	DIOR-/DIOW negated pulse width	25	-	
tL	DIOR-/DIOW to DMARQ- delay time	35	-	
tM	CS (1:0) to DIOR /DIOW valid time	25	-	
tN	CS (1:0) hold time	10	-	
tZ	DMACK- to tristate time	25	-	

4.7.3 Ultra DMA data in transfer (initialization timing)

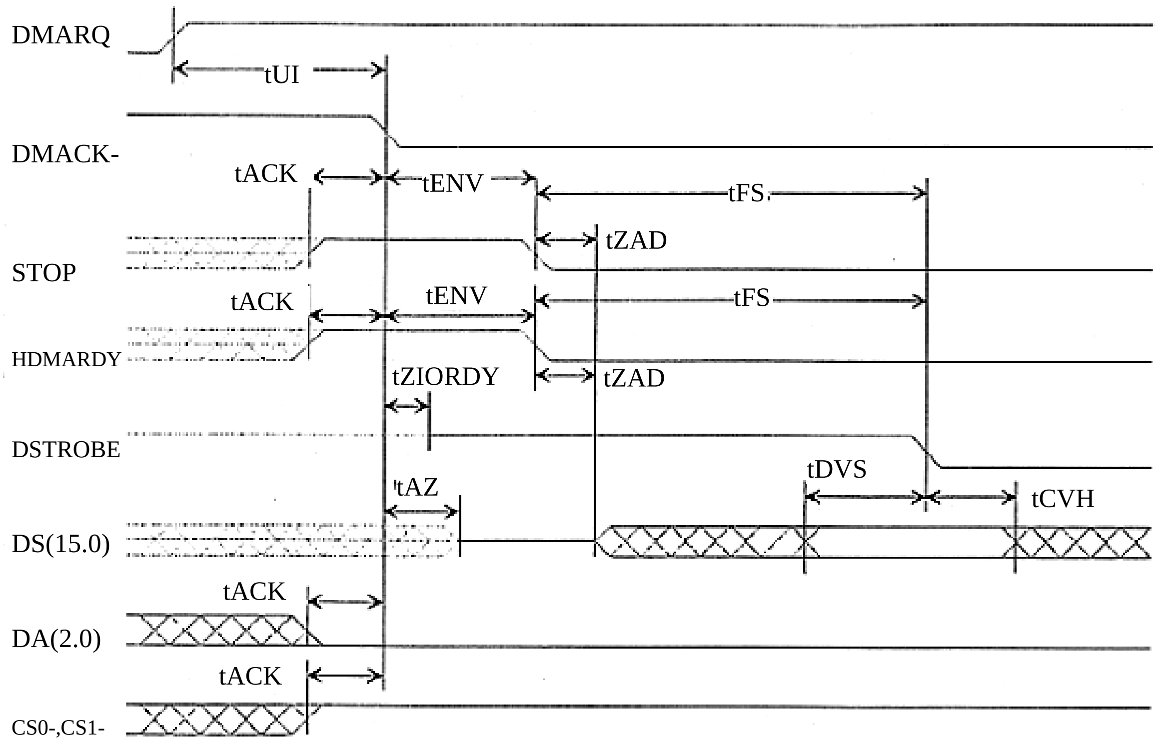


Figure 4.4 Ultra DMA data in transfer (initialization timing)

4.7.4 Ultra DMA data in transfer (continuous transfer timing)

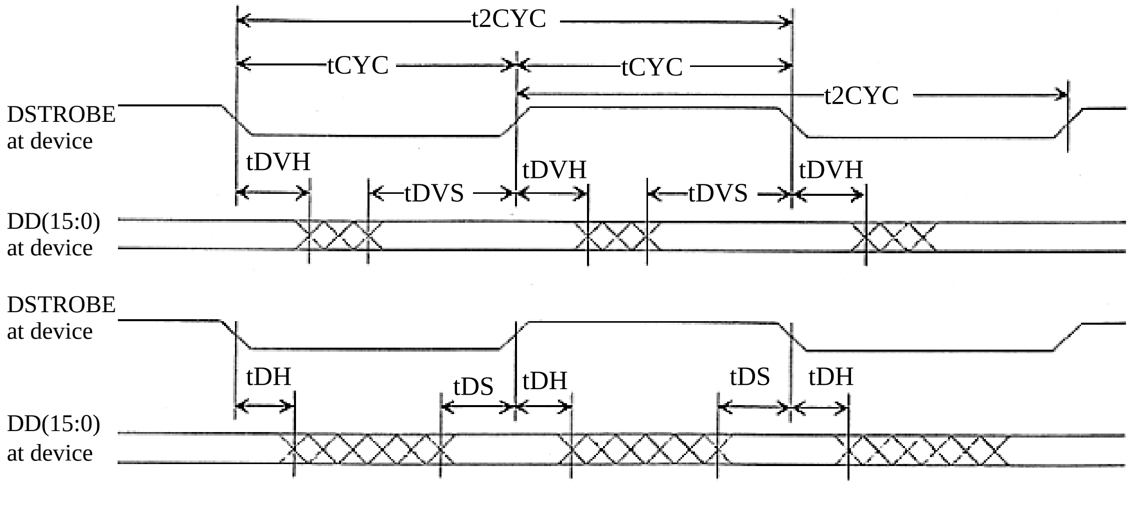


Figure 4.5 Ultra DMA data in transfer (continuous transfer timing)

4.7.5 Ultra DMA data in transfer (host stop timing)

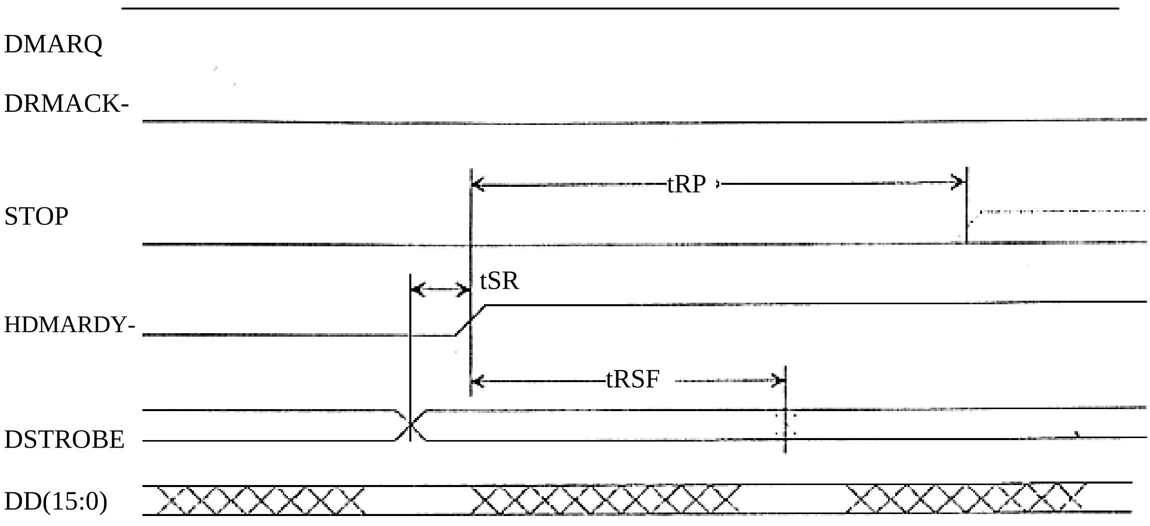


Figure 4.6 Ultra DMA data in transfer (host stop timing)

4.7.6 Ultra DMA data in transfer (device end timing)

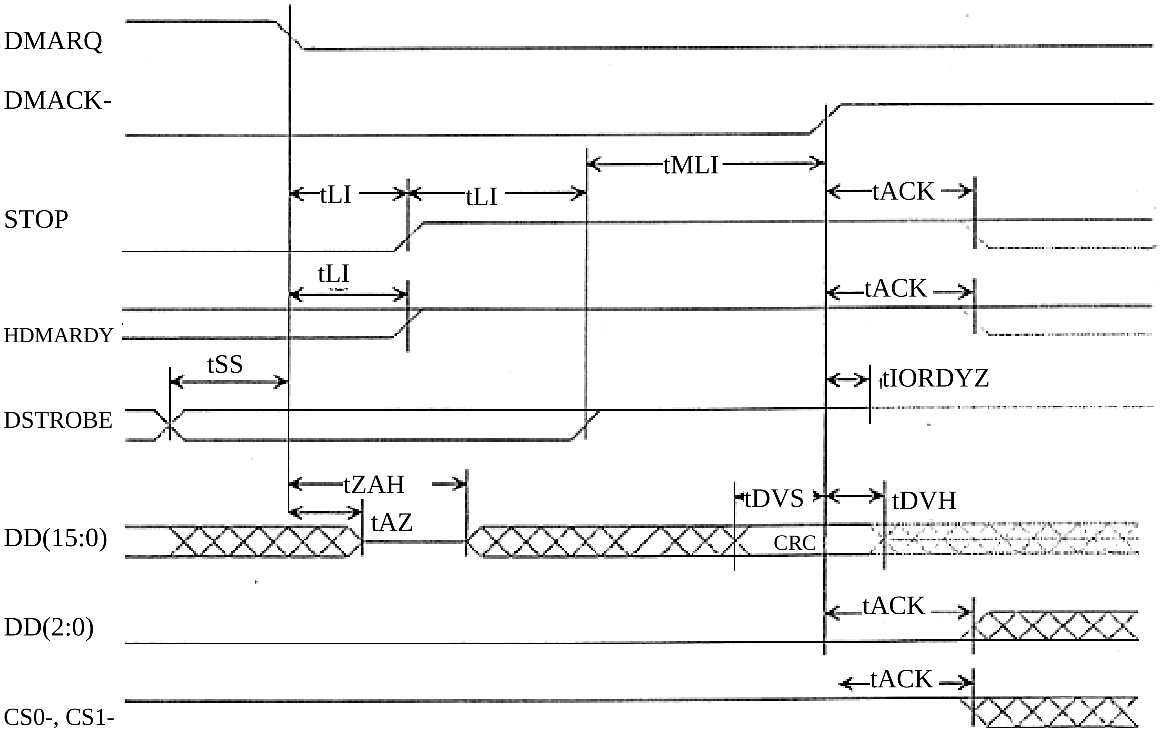


Figure 4.7 Ultra DMA data in transfer (device end timing)

4.7.7 Ultra DMA data in transfer (host end timing)

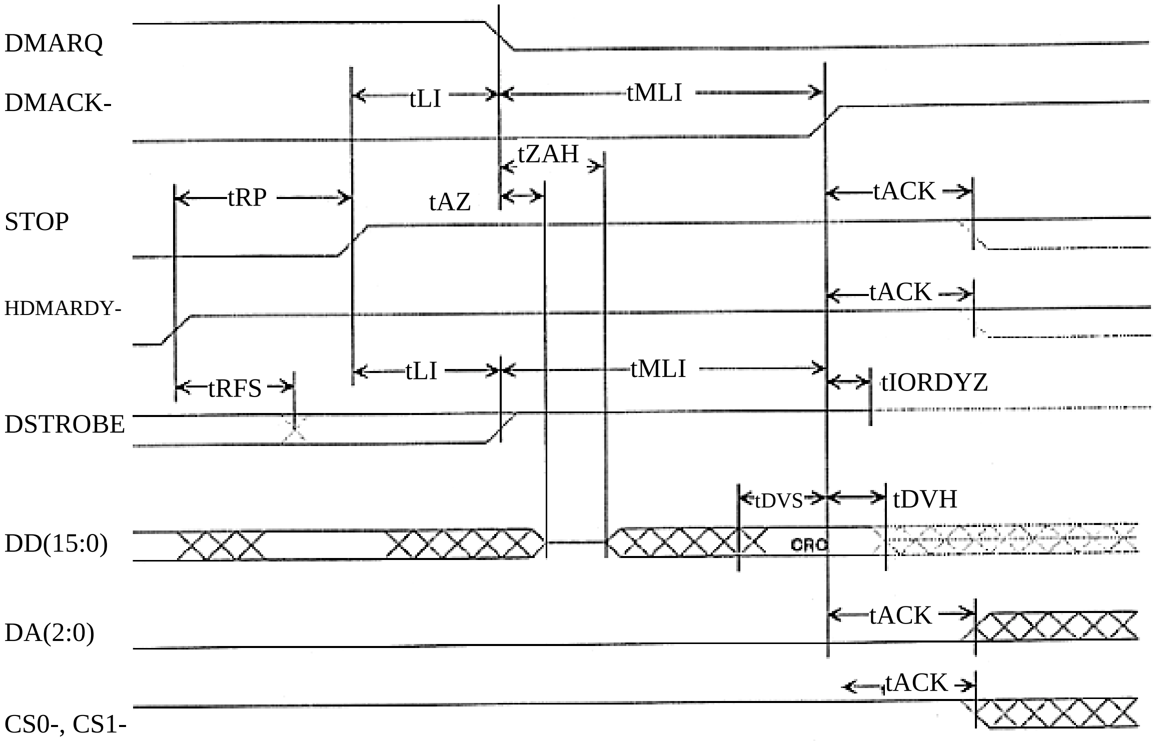


Figure 4.8 Ultra DMA data in transfer (host end timing)

4.7.8 Ultra DMA data out transfer (initialization timing)

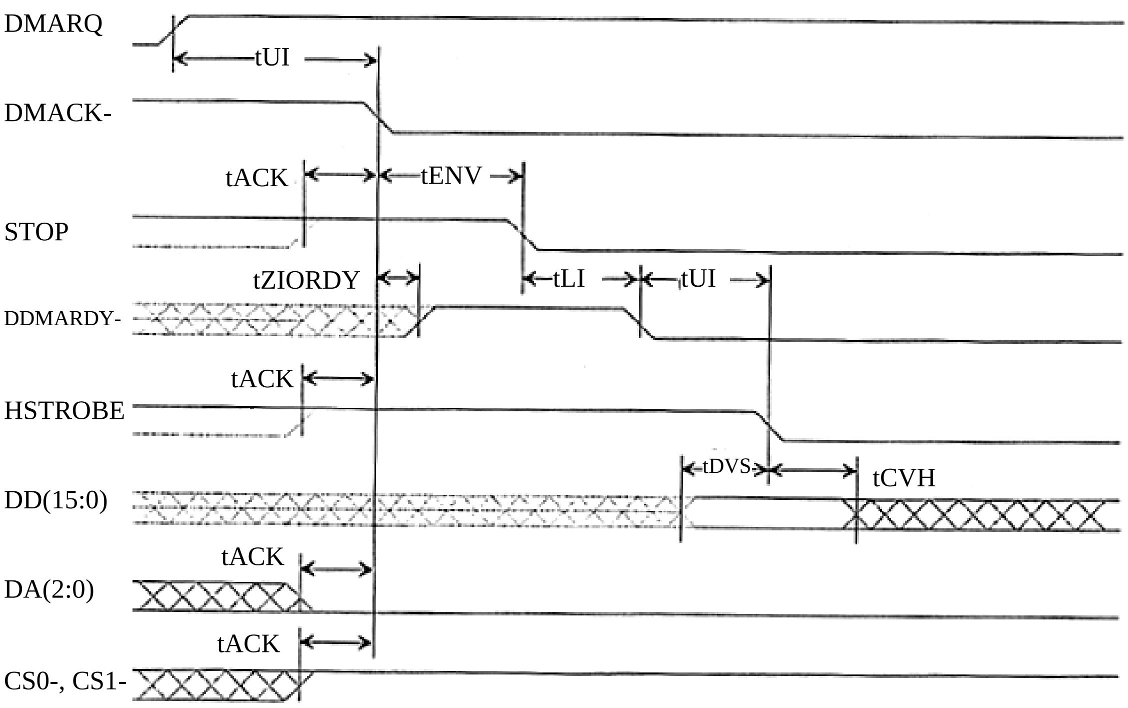


Figure 4.9 Ultra DMA data out transfer (initialization timing)

4.7.9 Ultra DMA data out transfer (continuous transfer timing)

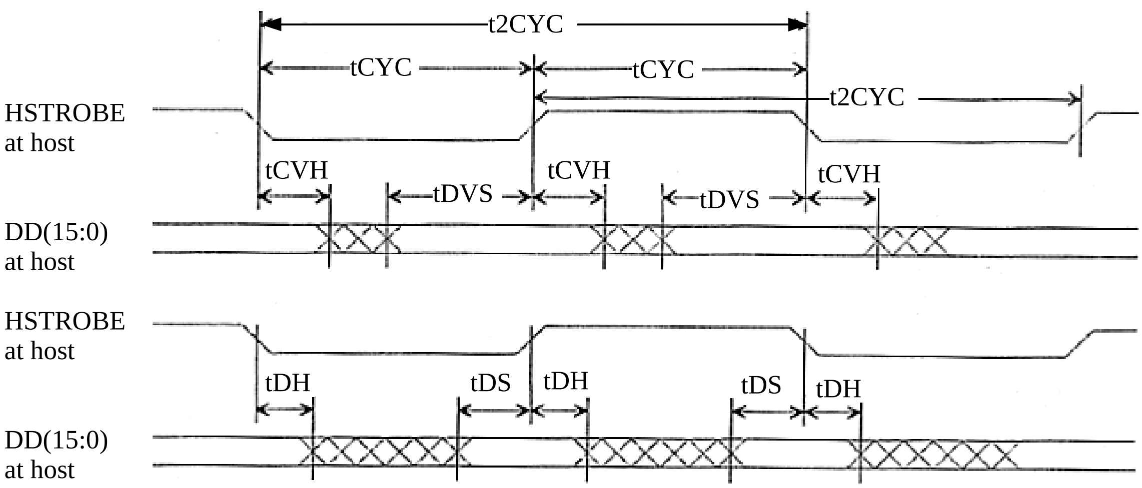


Figure 4.10 Ultra DMA data out transfer (continuous transfer timing)

4.7.10 Ultra DMA data out transfer (device stop timing)

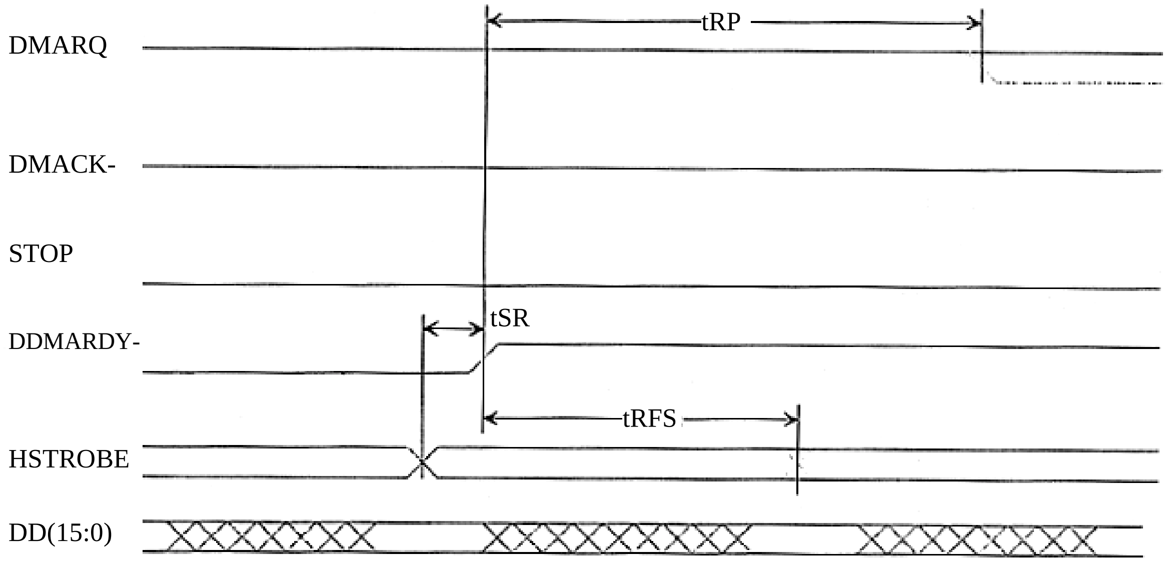


Figure 4.11 Ultra DMA data out transfer (device stop timing)

4.7.11 Ultra DMA data out transfer (host suspend timing)

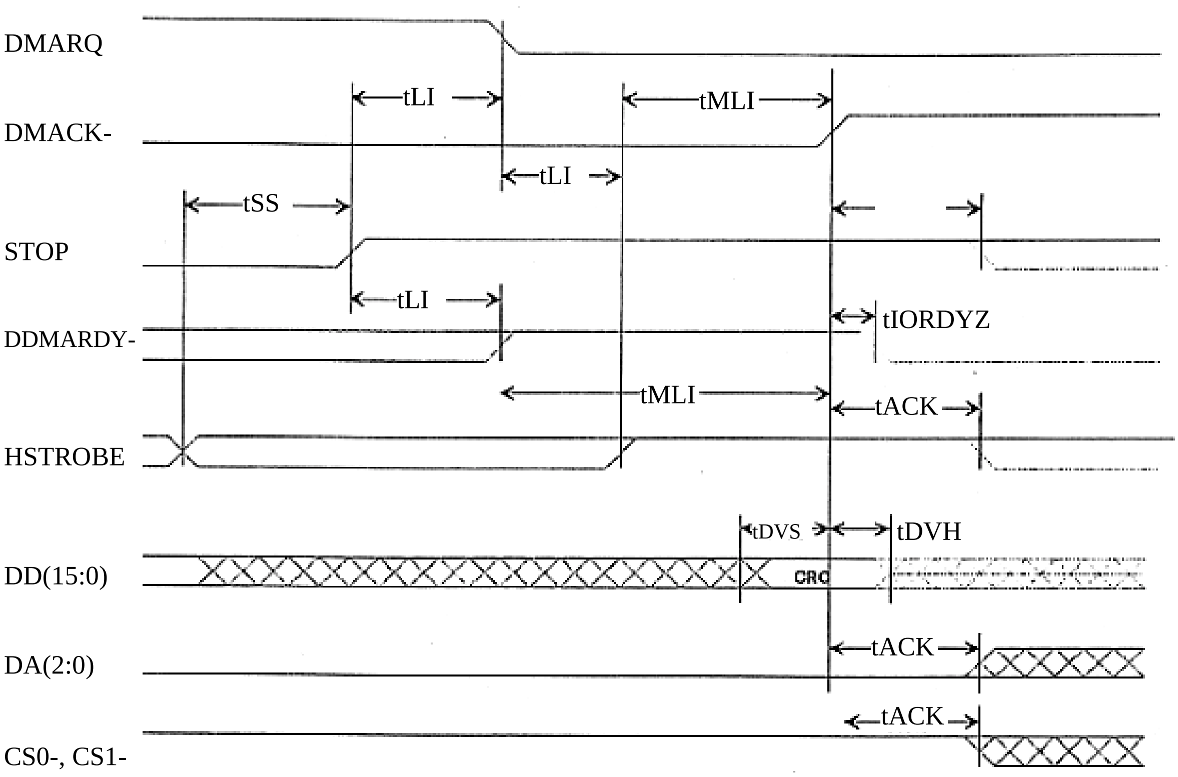


Figure 4.12 Ultra DMA data out transfer (host suspend timing)

4.7.12 Ultra DMA data out transfer (device end timing)

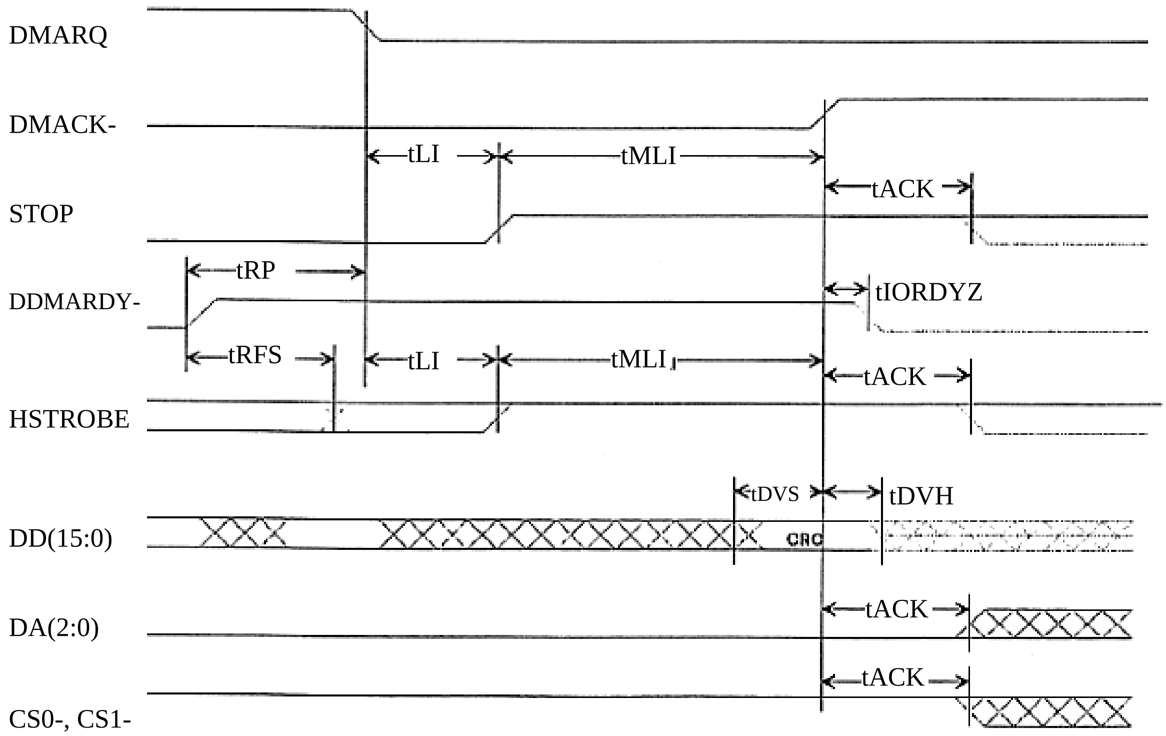
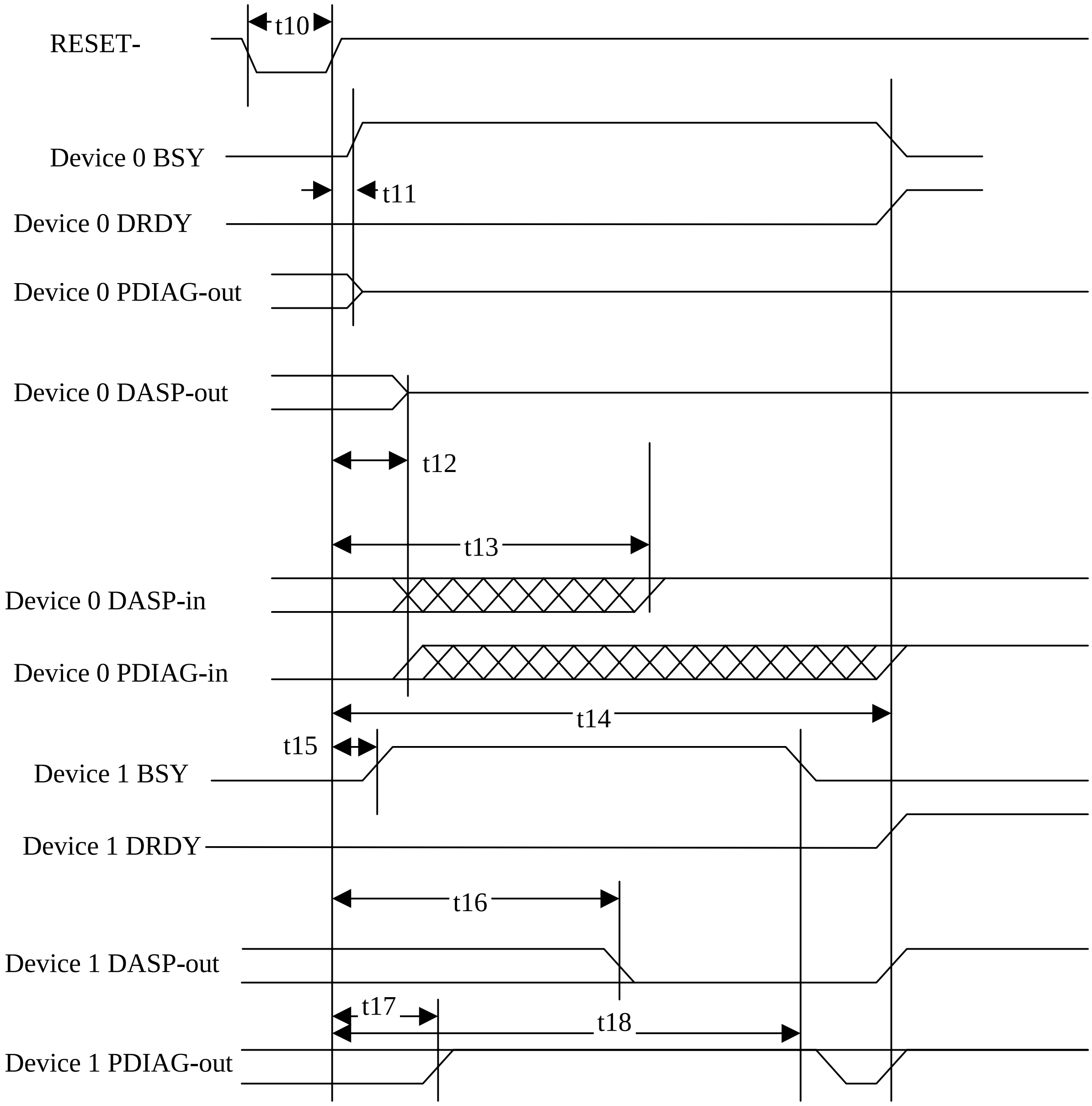


Figure 4.13 Ultra DMA data out transfer (device end timing)

Table 4.119 Ultra DMA data out transfer parameter

Symbol	Timing parameter	min (Units: ns)	max (Units: ns)	Condition
t2CYCTYP	Average 2-cycle time	120	-	Mode 2
tCYC	Cycle time (for non-target clock and at clock change)	54	-	
t2CYC	2-cycle time (at clock change)	115	-	
tDS	Data setup time on receiving side	7	-	
tDH	Data hold time on receiving side	5	-	
tDVS	Data enabled setup time on sending side	30	-	
tDVH	Data enabled hold time	6	-	
tFS	First strobe time	0	170	
tLI	Restricted interlock time	0	150	
tMLI	Minimum interlock time	20	-	
tUI	Non-restricted interlock time	0	-	
tAZ	Driver Maximum release time	-	10	
tZAH	Output delay time	20	-	
tZAD	Driver Assert and negate time	0	-	
tENV	Envelope time	20	70	
tSR	STROBE to DMARDY time	-	20	
tRSF	Ready to the last STROBE time	-	60	
tRP	Ready to stop time	100	-	
tIORDYZ	Maximum IORDY release time	-	20	
tIORDDY	STROBE operation minimum time	0	-	
tACK	DMACK- setup and hold time	20	-	
tSS	STROBE edge to DMARQ negate and assert time	50	-	

4.7.13 Power-on and Reset Timing



*1 Device 0 sets the BSY bit to 0 when device 1 is not connected.

*2 Device 0 uses DASP- to indicate that it is in operation when device 1 is not connected.

*3 DASP- is used to indicate that the device is in operation.

Figure 4.14 Power-on and reset timing

Table 4.120 Power-on and reset timing

Symbol	Timing parameter	min	max
t10	RESET- pulse width	25 µs	-
t11	Device 0 RESET- negation to BSY bit set to one, release PDIAG -	-	400 ns
t12	Device 0 release DASP-	-	1 ms
t13	Device 0 sample time of DASP-	1 ms	450 ms
t14	Device 0 sample time of PDIAG-	1 ms	31 s
t15	Device 1 RESET- negation to BSY bit set to one	-	400 ns
t16	Device 1 assert DASP-	-	400 ms
t17	Device 1 negate PDIAG - if asserted	-	1 ms
t18	Device 1 assert PDIAG-	-	30 s

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CHAPTER 5 Operation and Cleaning

This chapter describes how to operate and clean the drive and the optical disk cartridges.

5.1 Operating Optical Disk Drive

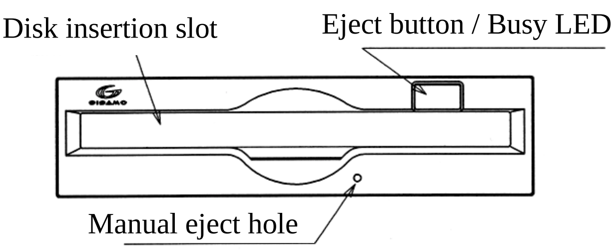
The drive has an automatic load function. All the operator must do is to insert the optical disk cartridge and operate the eject button.

This section explains loading and ejection methods, assuming that the drive is mounted horizontally. When mounted vertically, the drive is operated in the same manner as when mounted horizontally.

Figure 5.1 shows the front view of the optical disk drive. For operation, users should be familiar with the parts in the figure and their function. Loading and ejection methods are described below.

5.1.1 Optical disk drive

- Horizontal



- Vertical
  (Two orientations)

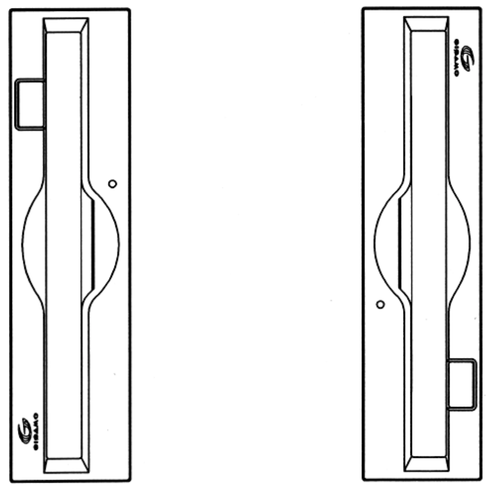


Figure 5.1 Optical disk drive front view (with panel)

The following explains the parts and functions of the optical disk drive (the following numbers correspond to the numbers in Figures 5.1):

1) Disk insertion slot

   Use this slot to insert and eject the optical disk cartridge.

2) Eject button & BUSY LED (display lamp)

   On this optical disk drive, this is the push button combining the eject button with the BUSY LED (display lamp) for ejecting the optical disk cartridge (it lights in green during seeking and during erasing, writing or reading of data). When ejection is disabled by the SCSI command, the optical disk cartridge cannot be taken out.

3) Manual eject hole

   This hole is used to eject the optical disk cartridge manually at power-off. Manual ejection may not be possible just after the power is off.

5.1.2 Note

To maintain the performance and reliability of the drive, keep the following point in mind:

- When the drive is in the busy state, do not eject the optical disk cartridge.

  Particularly, do not manually eject the cartridge by force.

- Be careful sufficiently not to insert the different drive (etc. floppy disk) or substance, so it is cause of the accident.

5.1.3 Inserting cartridge

Insert the cartridge as explained below. (See figure 5.2)

(1) When the drive power is on:

1) Make sure that no disk cartridge is in the drive.

2) Keep the cartridge shutter surface upward.

3) Insert the cartridge, shutter first, into the disk insertion slot.

4) Push the cartridge into the slot until it completes moving below (a little further in than the operator panel).

   Loading is started when the cartridge is inserted. After several seconds, the BUSY LED indicator lamp is turned on and immediately turned off to complete loading.

Notes

1) The cartridge must be completely inserted until the BUSY LED indicator lamp is lit.

2) If the cartridge is inserted by pushing either left or right side of the cartridge rear, it may not be inserted completely. Be sure to push the central part straight into the drive until it is completely inserted.

3) If the BUSY LED indicator lamp does not light when the cartridge is inserted, once eject the cartridge by pressing the eject/BUSY LED button and insert it again.

4) If you attempt to insert the cartridge by force, trouble may result in the drive. In such a case, be sure to once remove the cartridge and check the insertion direction and the face and back of the cartridge before inserting it again.

(2) When the drive power is off:

1) Make sure that no optical disk cartridge is in the disk drive.

2) Keep the cartridge shutter surface upward.

3) Insert the cartridge, shutter first, into the disk insertion slot.

4) Push the cartridge into the slot until it completes moving below (a little further in than the operator panel).

The cartridge remains inserted in the drive. The BUSY LED indicator lamp lights when the drive power is turned on.

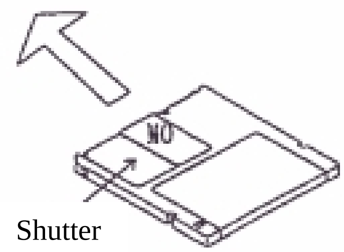
The cartridge remains inserted in the drive. Turning on the drive power starts loading. (The LED indicator lamp should light.)

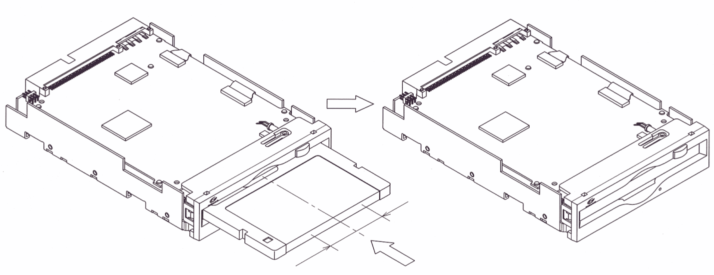
Notes

1) If the BUSY LED indicator lamp does not light when the power is turned on, once eject the cartridge by pressing the eject button and insert it again until the lamp is lit.

2) If the cartridge is inserted by pushing either left or right side of the cartridge rear, it may not be inserted completely. Be sure to push the central part straight into the drive until it is completely inserted.

3) If you attempt to insert the cartridge by force, trouble may result in the drive. In such a case, be sure to once remove the cartridge and check the insertion direction and the face and back of the cartridge before inserting it again.





Push by hand the width of 20mm to the right and left from the cartridge rear center, to the position shown at right.

Figure 5.2 Inserting cartridge

IMPORTANT

Even if you inserted the optical disk cartridge by pressing the left side of the rear edge with the cartridge shutter surface facing upward, and you heard a chucking sound, the device may not enter the READY state. In such case, press the center of the rear edge of the cartridge (check the dint part on the front side of the panel) further, until the LED indicator lamp goes on. This lamp indicates that the cartridge is normally inserted.

5.1.4 Ejecting (removing) cartridge

Remove the cartridge as explained below.

(1) When the drive power is on:

The cartridge can be removed by pressing the eject button. (See figure 5.3)

Notes:

1) If the ATAPI command prevents ejection, the cartridge cannot be removed.

2) Even if the drive set-up conditions are met, note that the cartridge can drop from the drive after ejection depending on the ambient environment and the cartridge's condition.

3) Remove the cartridge when completely ejected.

(2) When the drive power is off:

If the drive power is off, the cartridge cannot be removed by pressing the eject button. The cartridge can be removed by insert the eject jig (accessory) or a pin (diameter: about 1 mm) into the manual eject hole. (See figure 5.3)

Notes

1) NEVER attempt to eject the cartridge while the BUSY LED lamp is on. The data may be destroyed or trouble may result in the drive.

2) Note that the cartridge may drop from the drive when it is ejected.

3) The optical disk drive unit should not be carried around with a cartridge loaded inside.

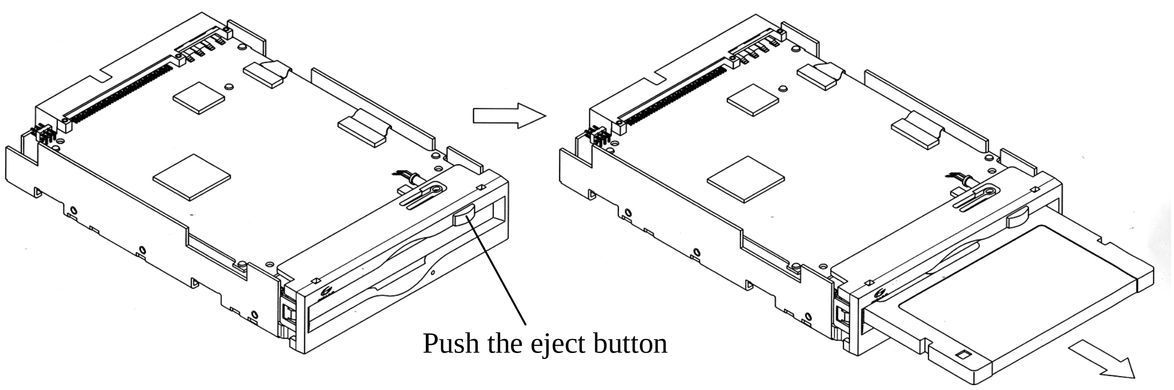


Figure 5.3 Removing cartridge

5.2 Cleaning Drive

When a dust or smoke of cigarette is stained to the lens actuator, a performance of whole drive may be down. Clean the lens actuator periodically using following head cleaner.

Note:

Cleaning period differs depending on the installation condition. Usually, cleaning period is once a three months.

Table 5.1 Head cleaner

Part name	Product number	Order number
Head cleaner	020470	CA90002-C980

(1) Cleaning method

Clean the head actuator with following method.

1. Turn on the power of the drive.
2. Insert the head cleaner.
3. When the head cleaner is automatically loaded, the optical head positioner moves back and forth and the cleaning brush mounted on the head cleaner cleans the object lens.
4. When the cleaning is finished, the head cleaner is automatically unloaded. (cleaning time: 15 seconds)

CAUTION

Device Damage: Be sure to use the dedicated head cleaner described above.

IMPORTANT

Check the cleaning brush state by opening the shutter of the head cleaner. If the tip of brush is open, use new head cleaner.

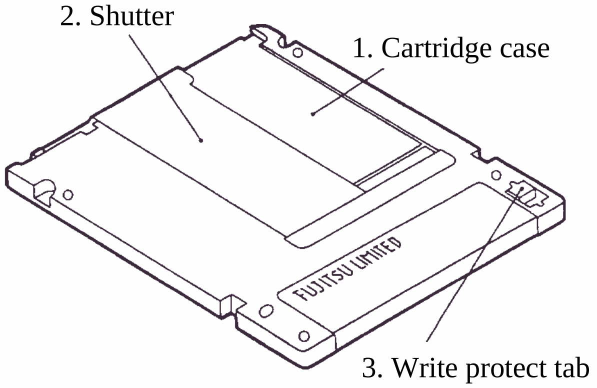
5.3 Optical Disk Cartridge Operation

5.3.1 Optical disk cartridge

Figure 5.4 shows the optical disk cartridge. For operation and cleaning, users should be familiar with the parts shown in the figure.

See Subsection 2.3.2 for the functions of the parts.

- Shutter closed



- Shutter open

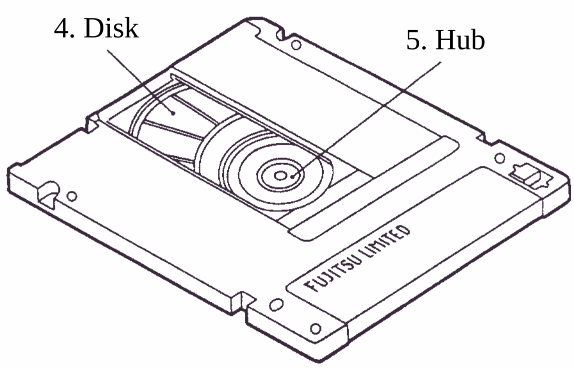
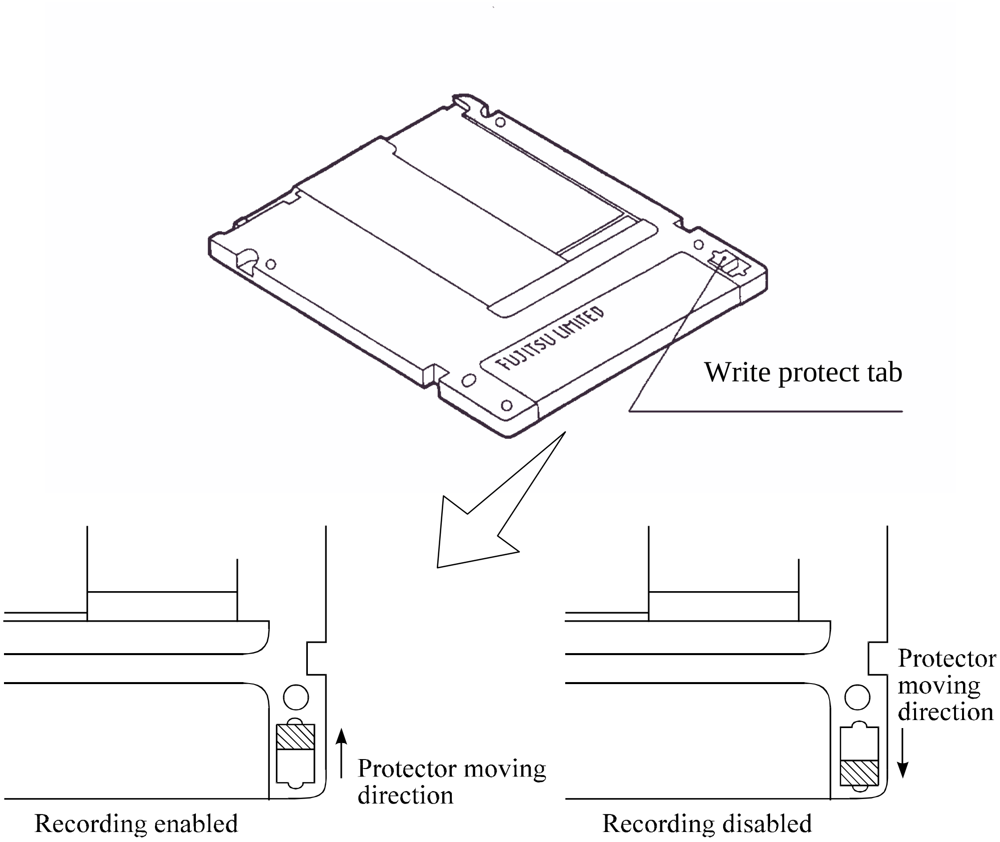


Figure 5.4 Optial disk cartridge

5.3.2 Write protect tab

Moving the write protect table determines whether to enable or disable writing of the optical disk cartridge. Use a fingernail to move the write protect tab (it must be completely moved to the end because there is play in the middle).

Figure 5.5 shows the write protect tab location on the optical disk cartridge and the moving state of the write protect tab (see "write enabled" and write disabled" entered on the label).



Note:

The hatched part indicates the write protect tab location.

Figure 5.5 Write protect tab

5.3.3 How to affix an index label on the MO cartridge (See figure 5.6)

(1) Note the following when affixing an index label:

- Be careful not to let the label become misaligned.
- Be sure to prevent the formation of air bubbles or peeling.

(2) How to affix an index label

Follow the procedure below when affixing an index label. (See Figure 5.x.)

1) Clean the surface of the MO cartridge before affixing the index label.
2) For a better finish, start sticking the index label from the backside of the MO cartridge.(a)
3) Once the backside is done, firmly press each corner of the index label.(b)
4) When the front is also complete, again press every corner of the index label to prevent the label from coming off.(c)



(a) (b) (c)

Figure 5.6 How to stick an index label on the MO cartridge

5.3.4 Notes

To maintain the performance and reliability of the optical disk cartridge, keep the following points in mind when using, storing, or transporting the cartridge:

(1) When using the cartridge:

- Do not use the cartridge where exposed to direct sunlight or where the temperature changes sharply, the temperature is high, or the humidity is high.
- Do not apply excessive pressure to the cartridge case or shutter. Avoid dropping the cartridge.
- Do not use the cartridge in a dusty or smoky place.
- Do not open the shutter or touch the disk surface.

(2) When storing the cartridge:

- Do not place a heavy objects on the cartridge.
- Do not store the cartridge where exposed to direct sunlight or where the temperature changes sharply, the temperature is high, or the humidity is high.
- Do not store the cartridge in a dusty or smoky place.

(3) When transporting the cartridge:

- Put the cartridge in a nylon bag to protect it from moisture.
- Put the cartridge in a strong container and cover the cartridge with cushioning material.

5.4 Cleaning Optical Disk Cartridge

Dust or cigarette smoke particulates on the disk surface lowers the performance of the cartridge. Regularly clean the disk. The cleaning frequency depends on the drive installation environment. Determine how often the drive should be cleaned in consideration of the environment. A standard of he cleaning period is every 300 hours usage or once a 2 to 3 months.

5.4.1 Cleaning tool

Use the cleaning kit to clean the disk cartridge.

(1) Cleaning kit

This cleaning kit is only for 3.5-inch optical disk cartridge. Use with reading the attached operation guide well. Table 5.2 shows the order number of the cleaning kit.

Table 5.2 Cleaning kit

Part name	Product number	Order number
Cleaning kit	0632440	CA90003-0702

Table 5.3 shows the packed items in the cleaning kit.

Table 5.3 Packed items (cleaning kit)

Name	Contents
Setting case	1 piece
Cleaning cloth	5 pieces (70mm??70mm)
Cleaning solution	1 bottle (20ml)

The following sub-kit is available as a set of the cleaning solution and cleaning cloth as supplement.

- Product No. 0632450
- Order No. CA90002-D901

CAUTION

Damage for disk medium: Use the cleaning solution and cleaning cloth specified in Table 5.2. If other than the specified items is used, disk media surface may be damaged.

(2) Notes on usage and storage of cleaning kit

- When storaging the cleaning solution, tighten the cap.
- As the magnet is used at revolving knob of the setting case, do not place the floppy disk near the revolving knob.
- Do not use or storage where exposed to direct sun light or near the inflammables.
- Keep out of the reach of children.

CAUTION

Damage for data medium: Do not use this cleaning kit for the floppy disk or the optical disk cartridge used for other optical disk drive.

5.4.2 Cleaning procedure

Clean the disk cartridge with a following procedure.

CAUTION

Damage for disk medium: Clean the cartridge at clean place. Put a disposable groves at cleaning so that the fingerprint does not put on the disk media (recommendation).

1) Slide the shutter completely open. (See figure 5.7)

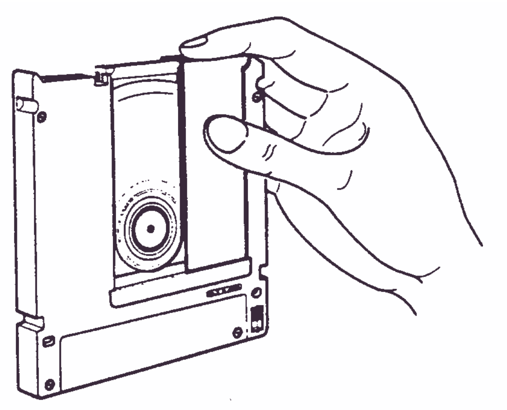


Figure 5.7 Cleaning procedure (1)

2) Set the cartridge with keeping label side down and shutter open to the shutter stopper of the setting case as shown in Figure 5.8.

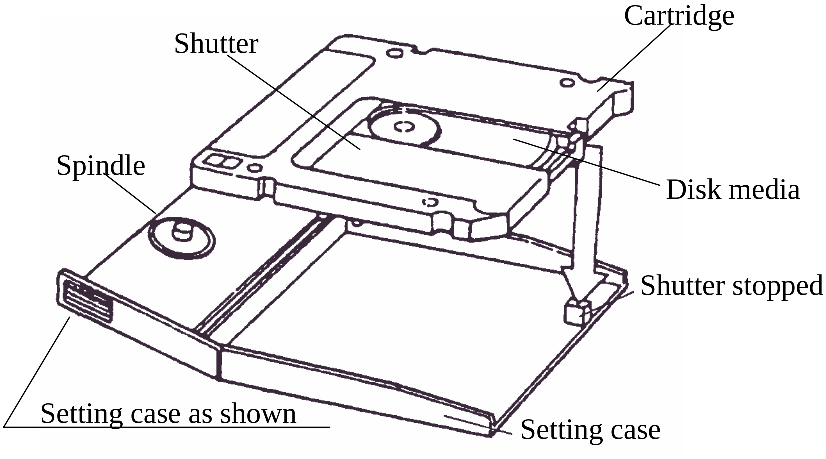


Figure 5.8 Cleaning procedure (2)

CAUTION

Damage for disk medium: At setting the cartridge to the setting case, do not apply the heavy shock and push hardly.

3) Cover the cartridge with the setting case cover, then insert the spindle pin into the center hub of the cartridge.

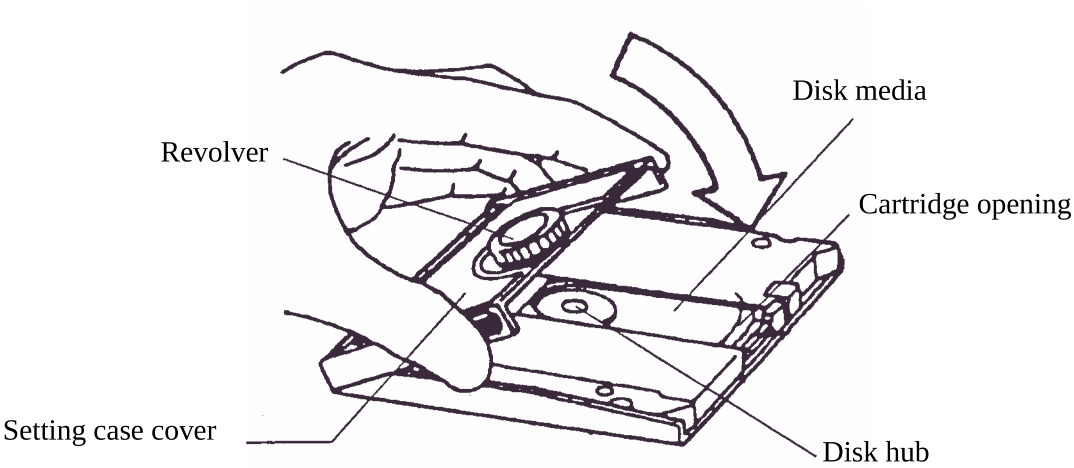


Figure 5.9 Cleaning procedure (3)

4) Remove a slender piece that causes a defect from the disk surface at wiping the disk media.

5) Moisten the cleaning cloth with a few drops of cleaning solution.

⚠CAUTION

Eye inflammation: In case of contact with eyes, immediately flush eyes with water.

6) Wipe the disk surface from the hub outward.

7) Turn the revolving knob, then wipe the disk surface.

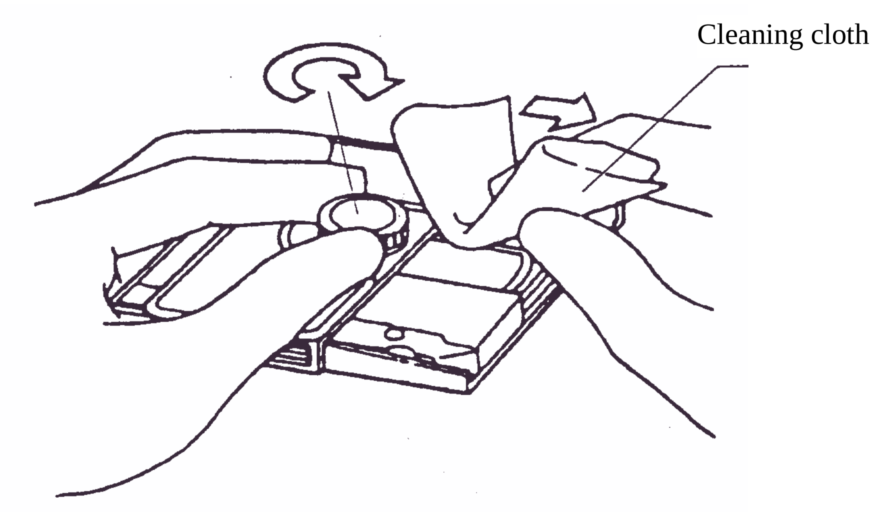


Figure 5.10 Cleaning procedure (4)

8) If the excess cleaning solution remains on the disk surface, wipe out with the cleaning cloth.

CHAPTER 6 Diagnosis and Maintenance

This chapter contains diagnosis and maintenance information.

6.1 Diagnosis

Table 6.1 shows a test executed by the diagnostic function.

The drive has a self-diagnostic function. This function can check the basic operations of the drive.

A test program running in the host system is required to check general operations, including operations of the interface with the host system. (See Subsection 6.1.3.)

Table 6.1 Self-diagnostic function

Diagnostic contents	Target
Initial self diagnosis	Basic operation (hardware function test)
Diagnostic command	Basic operation
Test program	General operation

6.1.1 Initial self-diagnosis

When the power is turned on, the optical disk drive starts initial self-diagnosis. Basic hardware functions are tested during initial self-diagnosis.

The hardware function test checks the normality of the basic controller operation. This test includes the normality check of the ROM in which microcodes are stored, microprocessor (MPU) peripheral circuit test, memory (RAM) test, and data buffer test.

If an error is detected during initial self-diagnosis, the LED on the drive front panel blinks.

6.1.2 Diagnostic command

The host system can make the ODD execute the self diagnosis by issuing the EXECUTIVE DEVICE DIAGNOSTIC command. See Section 4.7.2, "EXECUTIVE DEVICE DIAGNOSTIC", in details.

6.1.3 Test program

A test program running in the host system is required to check general operations such as operations of the interface with the host system and simulated operations.

The configuration and function of the test program depend on the user system requirements.

The test program should include the following tests:

(1) Random/sequential read test

Use the READ or VERIFY command to test positioning (seek) operation and read operation in random access mode and sequential access mode.

(2) Write/read test

Use a disk whose operation check data may be destroyed so that a write or read test can be executed with an arbitrary data pattern.

6.2 Maintenance Information

6.2.1 Maintenance requirements

(1) Preventive maintenance

No preventive maintenance is required.

(2) Service life

No overhaul is required within the first five years if the drive is used and handled in an appropriate environment.

(3) Service system and repair

Fujitsu provides a service system and repair facility for its optical disk drive. Submit information required to replace or repair the drive to your Fujitsu representative. The following information should be included:

a) Optical disk drive model, part number (P/N), revision number, serial number (S/N), and date of manufacture

b) Failure status

- Date of the failure
- System configuration
- Environment conditions (temperature, humidity, and supply voltage)

c) Failure history

d) Failure

- Description of the failure
- Issued commands and specified parameters
- Sense data
- Other error analysis information

⚠CAUTION

Data loss: In case of regular repair, the optical disk cartridge should not be attached except where the cartridge causes the error. And before having the drive repaired, save the data in the cartridge. Fujitsu is not responsible for data lost during maintenance or repair.

See Section 5.3.3 for details on packing and handling the drive when sending it to Fujitsu.

6.2.2 Revision number

The revision number of an optical disk drive is represented with an alphabetic character and a single-digit number. The revision number is shown on the revision label attached to the drive. For example, Figure 6.1 shows the revision label format.

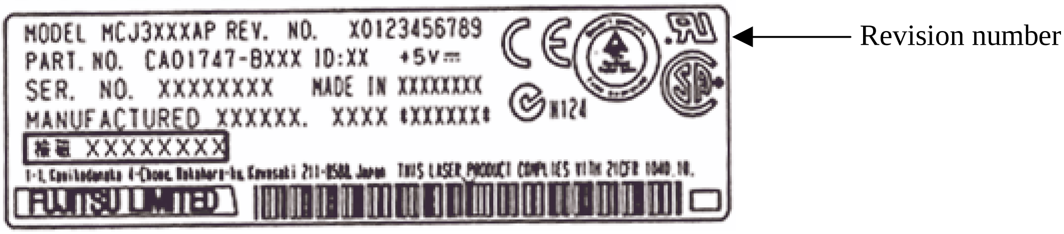


Figure 6.1 Revision label

(1) Revision number indication

When the drive is shipped, the revision number is indicated by deleting the numbers up to the corresponding number on the line of alphabetic characters. (Each number is deleted with double lines =. See Figure 6.2.)

(2) Changing the revision number on site

When the revision number is changed on site because of parts replacement or modification, the new revision number is indicated by circling the number on the line of alphabetic characters. (See Figure 6.2.)

NOTICE

When a revision number is changed after shipment, Fujitsu issues "Revision Number Change Request/Notice" to indicate the new revision number. The user must update the revision label as described above when changing the revision number.

Revision number indicated on shipment

REV. NO. A ~~0~~ ~~1~~ ~~2~~ 3 4 5 6 7 8 9 ⇨ Revision A2

Revision number changed on side

REV. NO. A ~~0~~ ~~1~~ ~~2~~ ③ 4 5 6 7 8 9 ⇨ Revision A3

Note: The "A" of the Revision Number is a stamp.

Figure 6.2 Revision number indication

Glossary

Axial acceleration

Acceleration on the recording layer along with the line perpendicular to the disk reference surface to a specified rotation speed. Axial acceleration is detected by optical means.

Axial displacement

A displacement at a point on the recording layer in a direction perpendicular to the disk reference surface from its original standard position. The standard position on the recording layer is detected optically using the thickness of the protective layer and refraction rate based on the disk reference surface.

Case

A cover of the optical disk. The case protects the disk from being damaged during handling and also allows the operator to exchange disks easily. The case also contains a label, write protection tab, automatic handling support, and media identification hole.

CDB (Command Descriptor Block)

A series of data describing input-output commands. CDB is sent from the initiator to the target.

Clamp area

A ring area on the disk on which a clamp force is applied by the clamp mechanism.

Command

An input-output instruction to the target. Described as CDB.

Control track

A track used to store media parameters and format information required to record and read data to or from the optical disk.

Defect management

In real time, an automatic program used to change the power, focus, tracking of reading and recording if an error is detected and to decide if many error sectors should be discarded. In batch mode, a guideline used to re-record or save the disk.

Disk reference surface

An ideal flat ring surface of an ideal spindle that is in contact with the clamp area on the disk. It is perpendicular to the rotation axis.

Error correction code

An error correction code designed to correct specific errors in data.

Error detection and correction

A series of data by adding a redundant code to data in the existing format. In read mode, the decoder removes a redundant code and detects and corrects errors using redundant information.

Interleaving section

A process that physically arranges data units so that data resists burst errors.

LUN (Logical Unit Number)

A device address used to identify a logical unit.

Recording layer

A layer on the disk on which data is recorded at production or recording .

Recording power

An incidence power specified on the incidence surface. Used to form marks.

Sense code

A single-byte code set in sense data. This information is used to determine the type of error detected.

Sense data

Information generated by the target to report detailed error information if any error information is contained in the command end status.

Sense key

A 4-bit code set in sense data. This information is used to classify the type of error detected.

Spindle

A component of the disk drive unit that is in contact with the disk and hub.

Status

A single-byte information reported from the target to the initiator at the end of each command execution. The status indicates the end status of a command.

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Acronyms and Abbreviations

A

AC	Alternating Current
ACK	ACKnowledge
ALPG	Automatic Laser Power Control
AM	Address Mark
ANSI	American National Standards Institute
ARRE	Automatic Read Reallocation Enabled
ASC	Additional Sense Code
ASCII	American Standard Code for Information Interchange
ASCQ	Additional Sense Code Qualifier
ATN	ATteNtion
AWG	American Wire Gauge
AWRE	Automatic Write Reallocation Enabled

B

BCV	Buffer Control Valid
BPV	Bit Pointer Varid
BSY	BuSY
BytChk	Byte Check

C

C/D	Control/Data
CCS	Common Command Set
CDB	Command Descriptor Block
CDRH	Center for Devices and Rediological Health
CRC	Cyclic Redundancy Code
CSA	Canadian Standards Association

D

DB	Data Bus
DBD	Disable Block Descripter
DBP	Data Bus Parity
DC	Direct Current
DCRT	Disable CeRTification
DDS	Disk Definition Sector
DMA	Defect Management Area
DPO	Disable Page Out
DPRY	Disable PRimarY
DSP	Digital Signal Processor

E

EBC	Enable Blank Check
EBP	Erase By-Pass
ECC	Error Correction Code
EN	European Norm
EVPD	Enable Vital Product Data

F

FG	Frame Ground
FIFO	First In First Out
FmtData	Format data
FOV	Format Options Valid
FRU	Field Replaceable Unit

G

GND	Ground

I

I/O	Input/Output
IC	Integrated Circuit
ID	IDentifier
IDD	Intelligent Disk Drive
IEC	International Electrotechnical Commission
Immed	Immediate
IP	Initialize Pattern
ISO	International Standardization Organization

L

LD	Laser Diode
LED	Light Emitting Diode
LoEj	Load Eject
LSB	Least Significant Byte
LUN	Logical Unit Number

M

MPU	MicroProcessor Unit
MSB	Most Significant Byte
MSG	MeSeaGe
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair

N

N.C.	No Connection

O

ODD	Optional Disk Drive
ODF	Offset Detection Flag
OEM	Original Equipment Manufacturer

P

PA	PostAmble
P/N	Part Number
PC	Page Control
PCA	Printed Circuit Assembly
PCF	Page Control Field
PCR	Parameter Code Reset
PDL	Primary Defect List
PEP	Phase Encoded Part
PF	Page Format
PLL	Phase-Locked Loop
PMI	Partial Medium Indicator
PPC	Parameter Pointer Control
PWM	Pulse Width Modulation

R

RAM	Random-Access Memory
RelAdr	Relative Addressing
REQ	REQuest
RH	Relative Humidity
ROM	Read only Memory
rpm	revolutions per minute
RST	ReSeT
RSV	ReSerVed

S

S/N	Serial Number
SB	Spare Band
SCT	SeCTor
SDL	Secondary Defect List
SDTR	Synchronous Data Transfer Request
SEL	SELect
SFP	Standard Formatted Part
SG	Signal ground
SKSV	Sense Key Specific Valid
SM	Sector Mark
SNSKEY	SeNSe KEY
SP	Save Page
SP	Save Parameter
STPF	SToP Format
SYNC	SYNCronization mark

T

TTL	Transister-transister-logic
Typ	Typical

U

UB	User Band
UL	Underwriters Laboratories Incorporated

V

VCM	Voice coil motor
VDE	Verband Deutscher Elektrotechniker
VFO	Variable Frequency Oscillator
VLD	VaLiD
VPD	Vital Product Data
VU	Vendor Unique

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